DECISION ANALYSIS MODEL FOR REFRESHMENT OF GEOBASE IMAGERY: BASIS FOR INVESTMENT STRATEGY

THESIS

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AFIT/GEE/ENV/03-05

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THESIS

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Matthew S. Craig

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Abstract

The United States Air Force is in the process of implementing GeoBase, an initiative to change how geospatial information resources are being acquired, implemented, exploited, and sustained on USAF installations around the world. Using GeoBase increases situational awareness and minimizes decision risk for all installation personnel. GeoBase is a geographic information system, using commercial-off-the-shelf software to provide one source for spatial information on an installation. GeoBase uses imagery as one layer of information. The accuracy of the imagery directly impacts the effectiveness of GeoBase.

The purpose of this thesis was to develop a decision model to be used in determining imagery refreshment in an installation's GeoBase program. A decision analysis model was developed based on the square footages of changes to the installation. A weighting method process was developed and used to better capture the mission priorities of the installation. This effort resulted in a mathematical equation providing a value representing the amount of change on an installation when compared with its imagery.

Results of this effort were tested using information from six installations from three different major commands. This model produces a value comparable across the Air Force and can assist in determining refreshment strategies at each MAJCOM.

DECISION ANALYSIS MODEL FOR REFRESHMENT OF GEOBASE IMAGERY:

BASIS FOR INVESTMENT STRATEGY

I. Introduction

Background

Air Force organizations worldwide make decisions every day. These decisions cost time, money, and manpower. The first step in making decisions is to gather pertinent information. Information, one part of the decision making process, comes in all shapes, sizes, and formats and may be received by the decision maker in visual, verbal, or mental form.

Air Force decision makers range from top commanders to lower-echelon base personnel. Different decisions require different types and amounts of information. Simple and routine decisions may require very little information, whereas the more complicated and permanent decisions may require significantly more information. Two areas of information which affect the decision maker's ability to properly make a decision are the amount and the accuracy of the information. The amount of information should only be sufficient enough to make the decision. Any additional information, not necessary to make the decision, can potentially distract or hinder the decision making process. A second measure of information is accuracy. The level of accuracy has a direct effect on decision making process. First, inaccurate information can lead to bad decisions. Second, the perceived accuracy of the information can decrease the level of confidence in the decision.

The primary role of the Air Force Civil Engineer is to "provide general and combat engineering; explosive ordnance disposal; disaster preparedness; environmental management; major accident recovery; fire protection; and mitigation and recovery from the effects of mass destruction (including nuclear, biological, and chemical weapons), peacetime emergencies, and terrorist incidents" (6:5). In support of Air Force and Department of Defense missions, many types of information are used to perform these functions. One type of information is geospatial data.

Geospatial data is "information about the location and shape of, and relationships among, geographic features, usually stored as coordinates and topology" (16:2). Geospatial information provides much more information than "traditional" paper maps, currently used by the military. "Traditional" maps use a two dimensional concept, typically depicting the location of a feature in relation to a point of reference or another feature. Usually, little more information is provided on these "traditional" paper maps.

The use of geospatial information, which encompasses additional elements of information, increases the military's flexibility and decision making ability (29). By increasing access to proper information and increasing the accuracy and timeliness of the information, the decision maker's ability to make decisions is enhanced.

Geographic Information Systems (GIS), a computer based tool, manipulates geospatial information for mapping and analyzing data with spatial components. A simple definition of GIS is "an organized collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information" (29). GIS applications have been used by many Air Force agencies to enhance the decision making

process in areas including Command and Control (C2), Operations, Facilities Management, and Environmental Resource Management. For example, situational awareness is a crucial component of effective C2 for a commander. Typically, one of the tools used to obtain situational awareness is a map. Using traditional paper maps with overlays depicting the evolving situation creates a potential problem of ensuring different decision makers have identical information. Using GIS applications ensures all decision makers have identical information simultaneously. This information can be updated in "real time" as events are occurring.

GeoBase is an initiative to change how geospatial information resources are being acquired, implemented, exploited, and sustained on United States Air Force (USAF) installations around the world (29). The mission of GeoBase is to "attain, maintain, and sustain one geospatial infostructure supporting all installation requirements" (31). The four mission impacts of GeoBase are Garrison GeoBase, GeoReach process, Expeditionary GeoBase, and Strategic GeoBase. Garrison GeoBase, the focus of the research, uses a single approach of geospatial management to replace the many overlapping mapping efforts across our Air Force installations (31).

The GeoBase Initiative began in the fall of 1998 when representatives from the communications and information community met with civil engineer agencies to explore how the two functional missions could share geospatial information resources (20:1-3). The origin of the initiative was an extensive scientific research paper conducted in 1995 by Brian J. Cullis. This paper examined the factors affecting successful use of geospatial information technologies by military organizations on US defense installation (20, 29)

GeoBase, used as software-based decision support tool provides information from a variety of different sources and includes people, processes, and resources used in the collection, analysis, and display of georeferenced data to support the installation (30). The method of displaying an installation's geospatial data is the Common Installation Picture (CIP). The CIP combines features extracted from a photograph, existing legacy data and an image to depict the infrastructure, facilities, and terrain of an installation. The image is used as a backdrop to enhance the decision process. A map uses common symbols to denote different features, whereas, a photograph will display the feature as actually seen by the viewer. This photograph of an installation can not be easily altered or updated to reflect changes in the actual conditions of the installation.

Problem Statement

A comprehensive plan does not exist for collecting, maintaining, and refreshing geo-spatial data on Air Force (AF) installations. The motto of the GeoBase initiative is "One Installation, One Map." In order to be an effective tool for commanders to use in making decisions, the "One" map must provide a complete and accurate depiction of actual conditions. The photograph used in the CIP must be updated periodically in order to provide accurate information. Over the course of a few years, changes on an installation may include demolishing buildings, roads, or other structures, and/or constructing new facilities or adding to existing facilities. As this process continues, the imagery that was taken begins to provide insufficient or inaccurate information.

The decision of how often and which method to use in updating the photograph incorporates many factors. Factors include cost, time, availability of methods, and level

of detail required. The method of obtaining an image is called remote sensing, which can be accomplished using airborne (aircraft), or space borne (satellites) platforms. Currently, no guidance or tools are available to assist in determining the frequency of updating an installations imagery map.

Research Objectives

The objective of this thesis research is to develop a decision tool to be used by any AF installation to assist in quantifying the amount of change in the installation's existing imagery with actual conditions. The ability to measure the level of change can provide information in determining when a refreshment of the image is necessary. The decision tool will have provisions for incorporating specific requirements for different installations.

Methodology

A multi-step approach was taken to develop a decision tool to be used in the GeoBase effort. The first step involves gaining a significant understanding of GeoBase, Geographic Information Systems (GIS), and imagery. The second step was developing a laboratory to accomplish two objectives: assist in learning and to facilitate research. Investigation of various decision analysis models was performed. A specific model was chosen to quantify the amount of change to an installation when compared with its imagery. The model chosen to be used as a decision tool for an installation is the mathematical model. The development of the model incorporated data collection,

equation development, evaluation, validation, and implementation. The final step identifies model limitations and recommendations of the model.

Relevance

GeoBase is an information management initiative that extends the Air Force's application of geospatial intelligence. Installation operations require the creation, management, and sharing of critical georeferenced information. This mapping tool assists the decision maker by increasing the overall situational awareness during any activity on an installation. The strategy of GeoBase emphasizes the organizational use of the information over the use of the individual hardware and software. The success of Garrison GeoBase can be attributed to a disciplined process to sustain accurate information. As installations change their facilities, their imagery becomes more inaccurate. As accuracy of the imagery decreases, an installation must determine when to refresh their imagery. This research provides a timely, quantifiable, and justifiable decision protocol for determining when an installation's imagery should be refreshed. The high cost of obtaining usable imagery requires a systematic approach to the decision making process when determining refreshment that meets the mission and provides cost savings from only refreshing when justified. The results of this research can be used by the installation, major command, or Headquarters Air Force in the overall management process of Air Force imagery.

Thesis Overview

The remainder of the thesis includes four chapters: literature review, methodology, results, and conclusions. Chapter 2 presents background information on AF installations, civil engineer squadron organization and responsibilities, Geographic Information Systems, GeoBase applications, and management decisions using GeoBase. Chapter 3 describes the methodology used in developing the mathematical model. Chapter 4 contains the results of the methodology, details the application of the methodology, discusses issues relevant to gathering and analyzing the data, develops the model, and evaluates the model. Chapter 5 summarizes the research results, identifies the strengths and weaknesses, and provides recommendations for future research in the area of GeoBase in the AF.

II. Literature Review

Introduction

The GeoBase program is an information initiative that extends the application of geospatial intelligence and associated tools to improve the situational awareness of Air Force personnel. This chapter presents detailed information related to the GeoBase program. The Military Organizational Structure and its Mission are presented to provide a background and to illustrate the role of GeoBase in the Air Force. A brief discussion of decision making is introduced to explain the basic tenets of decision making from an organizational perspective. A substantial explanation of geospatial information technologies to include Global Positioning System, Remote Sensing, geospatial information technologies, the GeoBase concept, and specific applications of geospatial technologies in the Air Force is provided in this chapter.

Military

The United States Air Force uses an organizational structure to provide a chain of command, to clarify capabilities of a given unit/activity, and to facilitate resource allocation. The design of the organizational structure is guided by five principles: emphasis on wartime tasks, functional grouping, lean organizational structures, skip-echelon structure, and standard levels (10:5). The top level of the Air Force organization is the senior headquarters of the Air Force (HQ USAF), consisting of two entities: the Secretariat (including the Secretary of the Air Force and the Secretary's principal staff), and the Air Staff, headed by the Chief of Staff. Within the Air Force structure are establishments, units, and non-units which report to HQ USAF. Establishments consist

of a headquarters unit and its subordinate units. An example of an establishment is a major command. Each major command in the Air Force contains a headquarters unit and numerous subordinate organizations under the headquarters. Units are defined as any military organization constituted by directives issued by HQ USAF. To provide an unbroken chain of command, all military personnel must be assigned to a particular unit. Additionally, each unit must have an officer designated as its commander (10:5-8).

The Department of the Air Force structure contains four major subdivisions directly reporting to Headquarters USAF. The organizations are Direct Reporting Units (DRU), Field Operating Agencies (FOA), Major Commands (MAJCOM), and Air National Guard (ANG). Figure 1 illustrates the arrangement of organizations within the Air Force. DRUs perform a mission that does not fit into one of the MAJCOMs, yet maintains equal administrative and organizational responsibilities as the MAJCOM. An example of a DRU is the United States Air Force Academy (USAFA), located in Colorado. The USAFA reports directly to Chief of Staff of the Air Force. FOAs differ from DRUs in two ways: FOAs report to a functional manager and may fall under HQ USAF or a MAJCOM.

An installation's overall mission determines which organizational units are needed to accomplish the mission. Different installations with similar missions will share similar organizational structures. These same installations will be grouped together and be part of a larger organization. An installation may have more than one mission, therefore more than one kind of organization structure. An installation may have a wing or a numbered air force (both part of a Major Command), direct reporting units, or a Field Operating Agency.

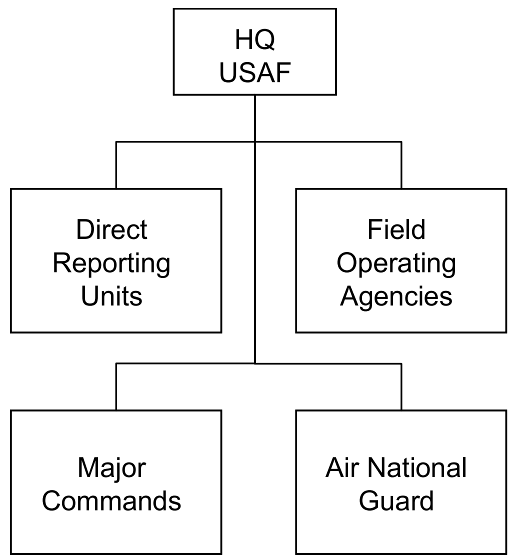


Figure 1: Department of the Air Force (21)

MAJCOM

One of the four major subdivisions in the Air Force is the Major Command (MAJCOM). Each MAJCOM, which reports directly to HQ USAF, consists of a skip-echelon structure. A MAJCOM contains lower organizational groupings to include numbered air forces (NAF), wings, groups, squadrons, and flights (10:9). An organizational chart in Figure 2 displays the major commands that report to the Headquarters US Air Force. The nine different commands are:

- Air Mobility Command (AMC)
- Air Combat Command (ACC)
- Pacific Air Forces (PACAF)
- United States Air Forces Europe (USAFE)
- Air Force Space Command (AFSPC)
- Air Force Special Operations Command (AFSOC)

- Air Force Material Command (AFMC)
- Air Education and Training (AETC)
- Air Reserves (AFRC)

Each MAJCOM has a unique mission with their set of requirements to complete their mission. The mission statement of ACC is, for example:

> "The U.S. Air Force's Air Combat Command, with headquarters at Langley AFB, VA, is the primary provider of air combat forces to America's Unified Combatant Commands. ACC operates fighter, bomber, reconnaissance, battle-management, rescue and theater airlift aircraft, as well as command, control, communications and intelligence systems" (1).

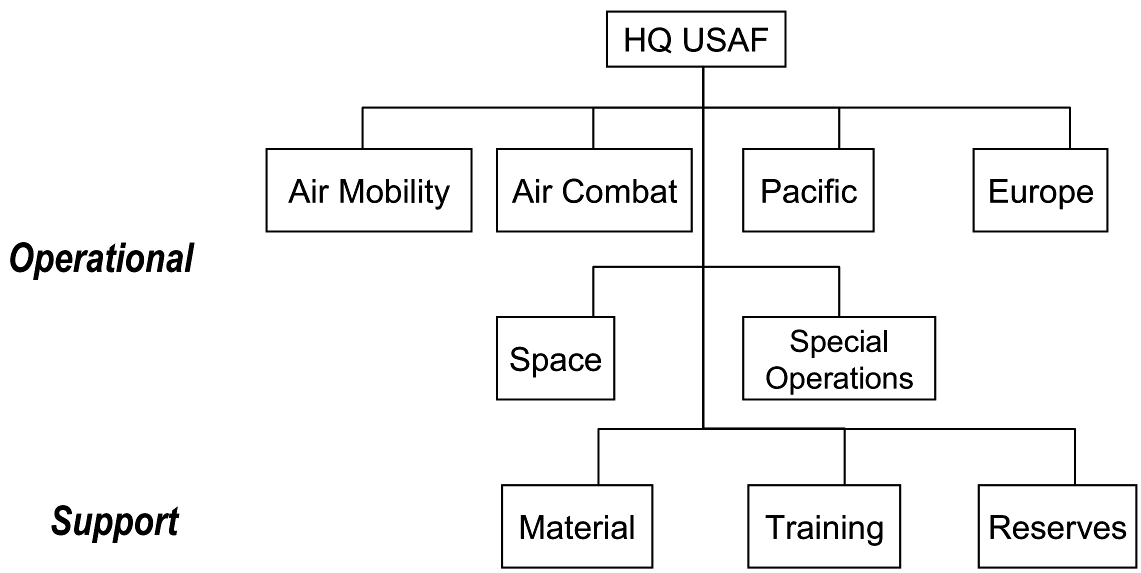


Figure 2: Air Force Structure (21)

Numbered Air Forces are the next subdivision under the MAJCOM. NAFs are a level below the MAJCOM and above the wing. Using the previous example, the Figure 3 displays the organizational chart for the ACC MAJCOM, ACC Numbered Air Forces, and ACC wings. Numbered Air Forces are a level of command under the MAJCOM and

over the wing. NAFs are responsible for MAJCOM operations in a specific geographic region or theater of operations. Following the chain down, NAFs are assigned subordinate units, such as wings, groups, and squadrons.

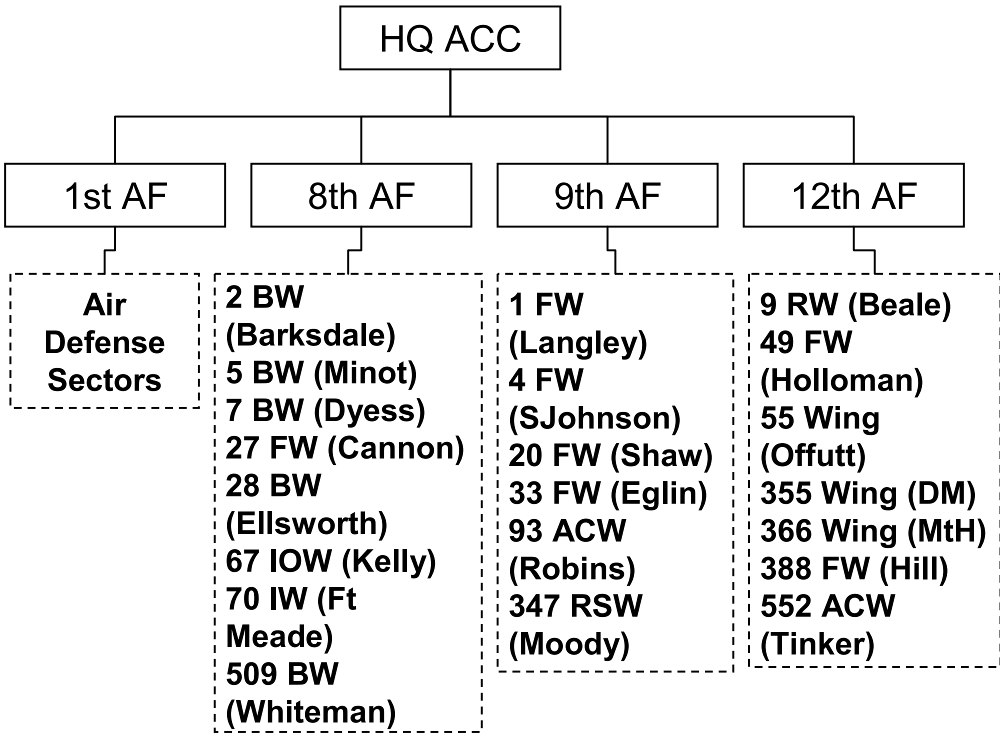


Figure 3: ACC MAJCOM Structure (21)

Wings

The level of command below a MAJCOM is called a wing. There are three types of wings: Operational, Air Base, and Specialized Mission. Each wing has a distinct mission with significant scope (10:10). Operational wings contain an operations group and related operational mission activity assigned to it. When an operational wing performs the primary mission of the base, usually the operational wing maintains the installation. Air Base wings do not have an operational mission, but a support mission primarily maintaining and operating the base. Specialized Mission Wings perform a

specialized mission, and do not have any aircraft or missiles assigned to the base. An example of a Specialized Mission Wing is the 37th training Wing (TRW) located at Lackland Air Force Base, Texas. This wing is the largest training wing providing basic military, professional and technical skills, and English language training for the Air Force, other military services, government agencies, and allies (23). If the wing is not responsible for maintaining the installation, a designated group or groups, containing several squadrons, is given the responsibility. Figure 4 shows a typical wing structure.

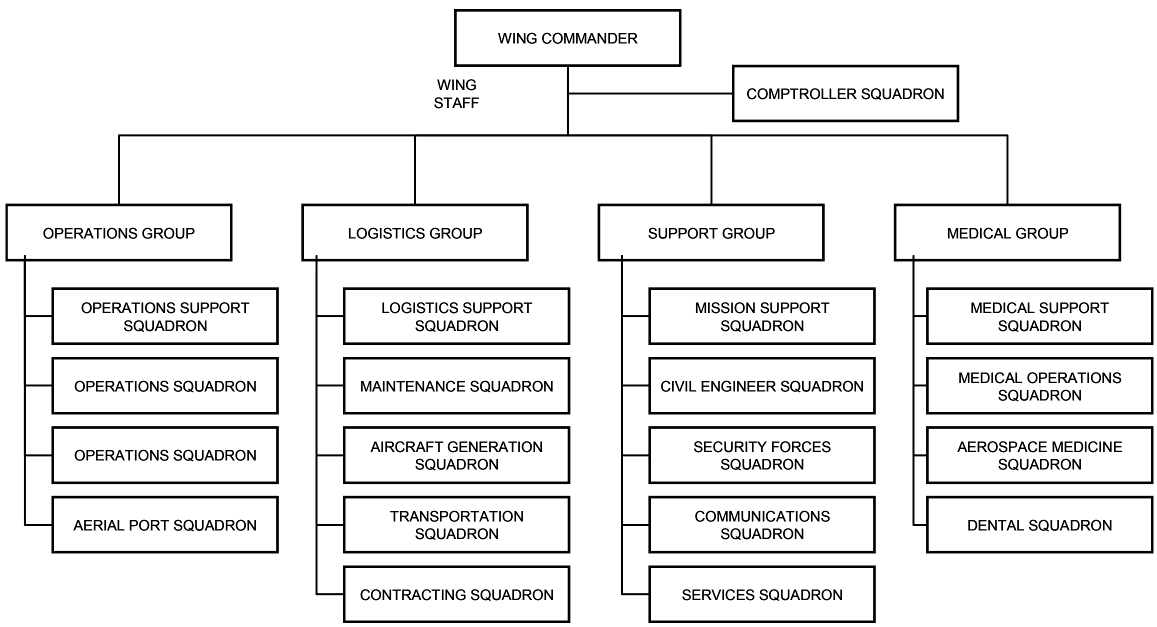


Figure 4: Wing Structure (10:19)

Groups

Groups are a level of command that report directly to a wing. Similar to a numbered air force, the group acts as tactical echelon and typically does not contain significant staff support. As in the wing, the group typically has two or more units under

its command (10:10). Groups are further divided into two different categories, dependent and independent. Examples of Dependent Groups include mission, logistics, support, and medical. Figure 4 contains Dependent Groups. Independent groups have similar functions to a wing organization, but its scope and size do not warrant a wing-level designation (10:10). For example, the 85th Group is in independent group located at Keflavik Naval Air Station (NAS), Iceland. This tenant unit is comprised of seven squadrons and thirteen staff agencies.

New Wing/Groups Organizational Structure

A new direction in the wing structure was directed by the Chief of Staff of the Air Force on June 20, 2002. This change effectively changed the names and components of the groups under each wing within the Total Force (Active, Guard, and Reserve). The purpose of the structure change was to attain an effective means to provide expeditionary power, handle an aging fleet, provide support personnel the training they need to deploy and sustain an operational presence anywhere in the world (3:2).

The deadline for full operational capability of this new structure is September 30, 2003 (12:4). Until this time, certain installations may continue under the old wing structure.

The new wing structure is called the Combat Wing Organization. This organization is "designed to fully develop commanders with specific functional expertise to fully plan and execute air and space power as part of expeditionary units" (3:1). The new structure also contains four groups: Operations, Maintenance, Mission Support, and Medical (12:A-I-1). Figure 5 illustrates the new wing organization. The Operations

Group contains the Operations Squadrons and the Operations Support Squadrons. The Maintenance Group will contain all the aircraft/missile maintenance squadrons. The Mission Support Squadron incorporates all the installation support, contingency, contracting, and other support functions. The Medical group was not reorganized (3:1-2).

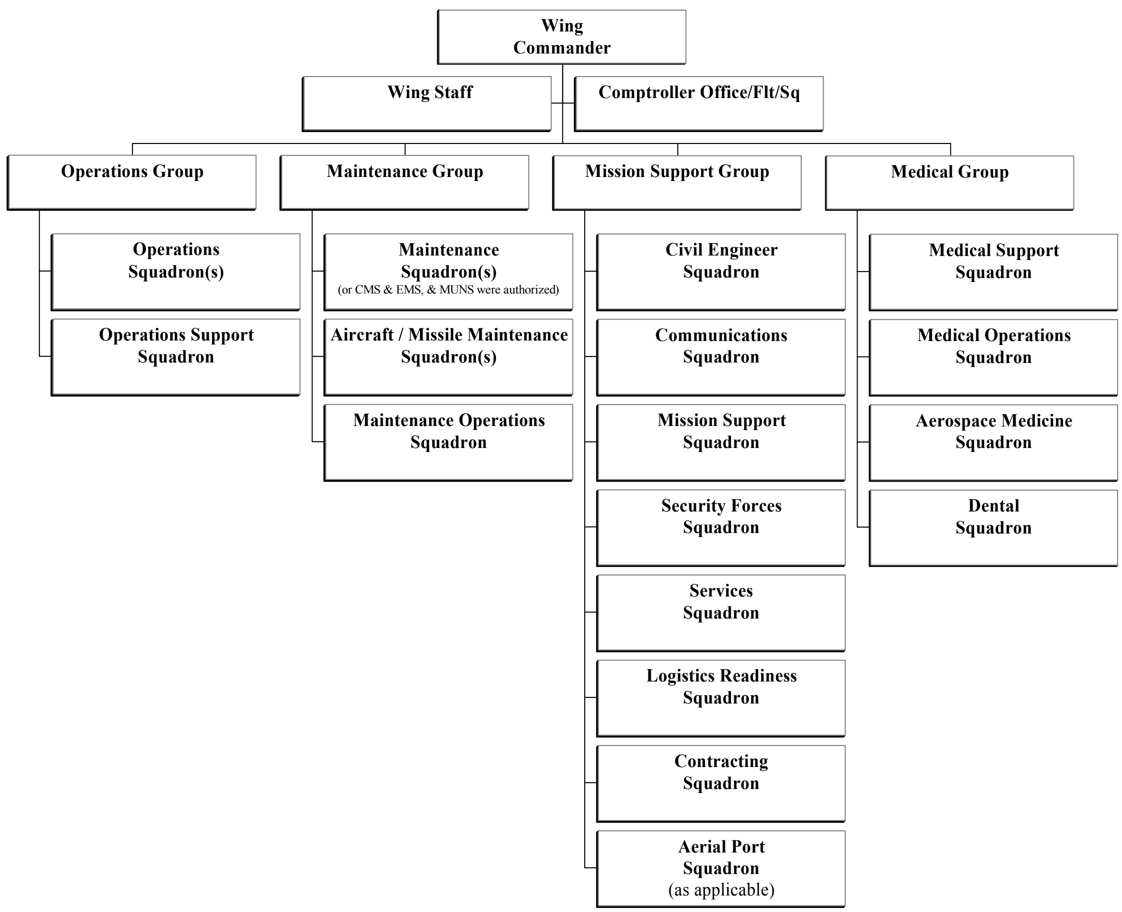


Figure 5: New Wing/Group Structure (12:A-I-1)

Decision Making

All organizations make decisions everyday ranging from policy, strategy, short and long-range plans and day-to-day operations. Making these decisions even harder are

constraints on funds, time, resources, and information. Proper information is vital to making a good decision. Information should be relevant, accurate and sufficient to ensure that the decision-maker has the information needed to make a suitable decision (4:3).

The decision making process should be a careful systematic approach, especially when making difficult decisions. Typically, a well-executed approach to making difficult decisions incorporates a step-by-step approach. There does not exist a set list of steps to follow in making good decisions, rather general guidelines. One general guideline includes the analysis of data. A list of alternatives can be generated from the data analysis and a decision can then be made. As can be expected, more than one way exists to analyze or examine data. A common method of examining data is modeling.

Geospatial Information Technologies

Geography seeks to describe the world's human and physical features through an analysis of place and location. An important element to the concept of place and location is using a single reference point. For example, Earth provides a single frame of reference, which allows the geographer to locate any feature relative to a single location and then study the spatial interrelationships. Spatial data refers to the information about a location of a feature, the shape, and the relationships among geographic features.

Recently, the invention of the computer has considerably advanced the method and the speed in which we collect and analyze data (5:3). Three different innovations are responsible for the significant increases in the ability to collect, analyze, and organize large amounts of geographic data. They are Global Positioning System (GPS), remote

sensing, and geographic information systems (GIS) (5:3). Remote sensing produces imagery maps, which is part of geospatial technology.

Global Positioning System.

GPS, originally named the Navigation System with Timing and Ranging (NAVSTAR), was developed by the US Department of Defense (DoD) to provide 24-hour worldwide weather information used for navigation by US military forces (17). GPS has become an integral part of numerous civilian applications, providing information to many thousands of civilian GPS users (17; 18). GPS employs 24 satellites in six orbit planes with four operational satellites in each plane, as shown in Figure 6. These satellites use triangulation to determine a particular location on Earth (17; 18). GPS, a valuable tool for surveying, is one of the primary methods used to update an installation's maps.

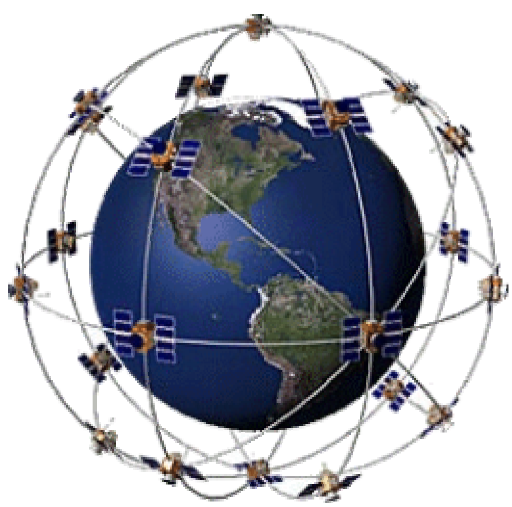


Figure 6: Global Positioning System (24)

Remote Sensing.

A general definition of remote sensing involves gathering data and information about an object or objects without physical contact (26). A geographer's definition of remote sensing typically includes the technology of acquiring information about the earth's surface (features) and atmospheric information using sensors (26). Geospatial data refers to a geographic feature that can be located using a coordinate plane or from a single point of reference. Common methods used in remote sensing include aerial photography, radar, and satellite imaging (16). Imagery technology allows airborne commercial sensors to collect imagery with less than one-meter resolution across the visible, infrared, and microwave regions of the electromagnetic spectrum. This advanced capability improves the surveyor's ability to map existing features and changes to an area. Imagery has replaced analog photography (commonly used by installations in the past). Imagery is used on installations as a mapping tool due to its ability for geographic feature extraction. Geographic features are defined according to the Environmental Systems Research Institute (ESRI) as physical objects that can be represented using geographic data sets. Examples of geographic features include streets, sewer lines, manhole covers, accidents, lot lines, and parcels.

Imagery.

Remote sensing produces images using photographic or digital systems. Photographic systems use light sensitive film to take pictures of a geographic area. Digital images are created when electronic sensors collect data from a geographic area

and a computer generates a picture. The GeoBase imagery layer may be acquired using either photographic or digital methods.

Photographic images include black and white panchromatic or infrared, color, and color infrared film. One problem with photographic images is distortion. Distortions alter the actual appearance of size and shapes of geographic features. Distortion of an image is measured usually spatial resolution. Spatial resolution is the size of the smallest identifiable feature on the image. Photographs typically provide high spatial resolution. An image resolution of 1-meter identifies features equal or larger than one square meter.

Digital images provide two- and three-dimensional images. Multi-spectral and radar sensors produce two-dimensional images. Multi-spectral digital images collect data on different sections of the electromagnetic spectrum. Satellites and aircraft can be equipped to obtain multi-spectral and radar sensors. Three-dimensional images are produced by Light Detection And Ranging (LiDAR) sensors. LiDAR uses a laser attached to an airplane to detect the elevation and location of features in a particular geographic area. LiDAR is usually combined with spectral imagery to provide horizontal and vertical feature information.

Satellite imagery is available from a variety of sources to include the National Imagery and Mapping Agency (NIMA), United States Geological Survey (USGS), and commercial companies. A DoD organization can obtain digital imagery from NIMA or a commercial organization directly. If an organization requests imagery that NIMA does not have, an existing NIMA contract can be used to purchase the imagery at a low cost. As the availability of imagery increases, the cost decreases. Currently, 1-meter imagery of all installations is available through NIMA at little or no cost which can be used by

GeoBase. Unfortunately, very few installations are aware of this capability and the process to obtain the imagery is complicated.

Geographic Information Systems (GIS).

GIS in the strictest sense is a "computer system capable of assembling, storing, manipulating, and displaying geographically referenced information, i.e. data identified according to their locations" (33). GIS is an organized collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information (16). This information is displayed using a common spatial coordinate system as the primary means of reference.

Unlike a paper map, GIS may contain many layers. Figure 7 provides a visual depiction of the different layers. The main difference between a paper map and a GIS map is the database that is attached to the GIS map. A database or a set of databases contains information about different points or features on the GIS map. For example, the GIS map will show the relative position of a building, but also provide other information to include building dimensions, number of floors, age, or list all renovations. A paper map only displays information on the paper.

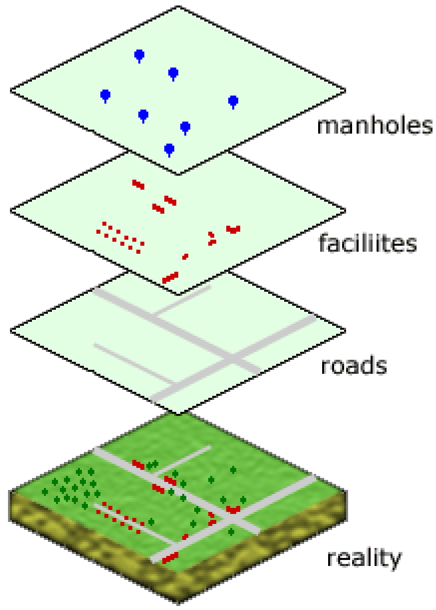


Figure 7: Example of GIS Application (29)

Air Force Application of Geospatial Information Technology

Since 1989, the DoD has placed an increasing emphasis on the operation of a base's sustaining activities on a more business-like basis (13:1). A major focus involves installation services and facilities. Roughly, $40 billion is spent by the DoD on over 400 installations in managing over $1 trillion in assets (13:1). In the U.S., our installations support approximately 1 million active military members, 2 million family members, 800,000 civilian employees, and 1 million military retirees. Over the years, significant investments in GPS, remote sensing, and GIS were made typically from civil engineers and environmental managers. These investments attempted to improve the existing processes used in maintaining and operating the installation. One of the problems associated with these investments was the limited sharing ability of these programs. The

magnitude and complexity of all of the DoD's information technology resources require effective and efficient management.

Unfortunately, numerous surveys and studies have indicated serious problems with the DoD's IT investments. The General Accounting Office (GAO) reported almost 70% of new IT investments across federal agencies were failing due to non-technical reasons such as inadequate management of information systems development life cycle, ineffective oversight and control of IT, and the inability of systems to work together (33:8). In the 1980's, the Air Force invested in GIS, GPS, and remote technologies, but encountered similar problems identified by the GAO. These reasons were attempted to be addressed in the Clinger-Cohen Act.

Consequently, the DoD sponsored a three year study of geospatial IT adoption on defense installations in 1992. The intent of the study was to identify the social and technical factors that might affect adoption (5:10). Results of the study revealed numerous problems with the use of geospatial IT on defense installations. Almost two-thirds of the installations had no specific objectives for their investments. In almost all cases, no attempt was made to share geospatial information across the installation. The most significant problem was that none of the organizations had changed their internal operating procedures to use geospatial information (5:11). Organizational processes and cultures changed very little to accommodate the new technology.

Poor management of information on an installation and across organizations has caused significant difficulties. Information mishaps are frequently reported at the base level. Examples include: (a) a communications contract to lay cable in a location where a newly constructed road was completed by the civil engineer squadron; (b) a backhoe

operator disrupting a communication line due to inaccurate maps; and (c) weapons safety managers discovering new base housing foundations violated the quantity-distance arcs from recently repositioned munitions (5:11).

A solution to this information problem can be found in the conclusions of the DoD sponsored study. Two of the conclusions from the study are: (a) "all users within the battlespace infosphere have a need for georeferenced information to accomplish their tasks in the most efficient and effective manner; (b) the optimum solution would be to establish a common geospatial framework for all warfighters so the defense department can improve interoperability and maximize the return on its GIS investment" (5:12). The development of a common geospatial framework, which would provide users access to the information necessary, results in a Common Installation Picture (CIP).

The CIP is an effective tool to help eliminate situational confusion at the unit level (5:16). Situational confusion exists when information is inaccurate, outdated, inaccessible, or inadequate. Currently, units collect information relevant to their mission tasks and organize it in a framework they are accustomed and typically accessible only to them, as illustrated in Figure 8. For example, the Security Forces may use a paper-base map, sectioning the base from a security perspective. The Civil Engineers typically use non-georeferenced CAD system displaying their information from a base-wide perspective. Additionally, the communication squadron may have their own set of maps detailing the location of existing and future communication lines using a non-georeferenced CAD graphic different from the Civil Engineers. Another source of information is the surrounding region. This layer of information is generally collected by only one functional element, Civil Engineers. Because of the different types of data

displayed separately, commanders typically do not have access to a complete and accurate depiction of existing conditions.

The information collected by the different functional elements tends to stay with each functional unit. Commanders and functional units do not necessarily have access to other functional's information, which may lead to inaccurate information. Inaccurate information can cost an organization time, money, and resources, and possibly introduce safety risks. Back to the earlier example, the backhoe operator using a map printed from the CE shop would have the new updated fiber optic lines on it.

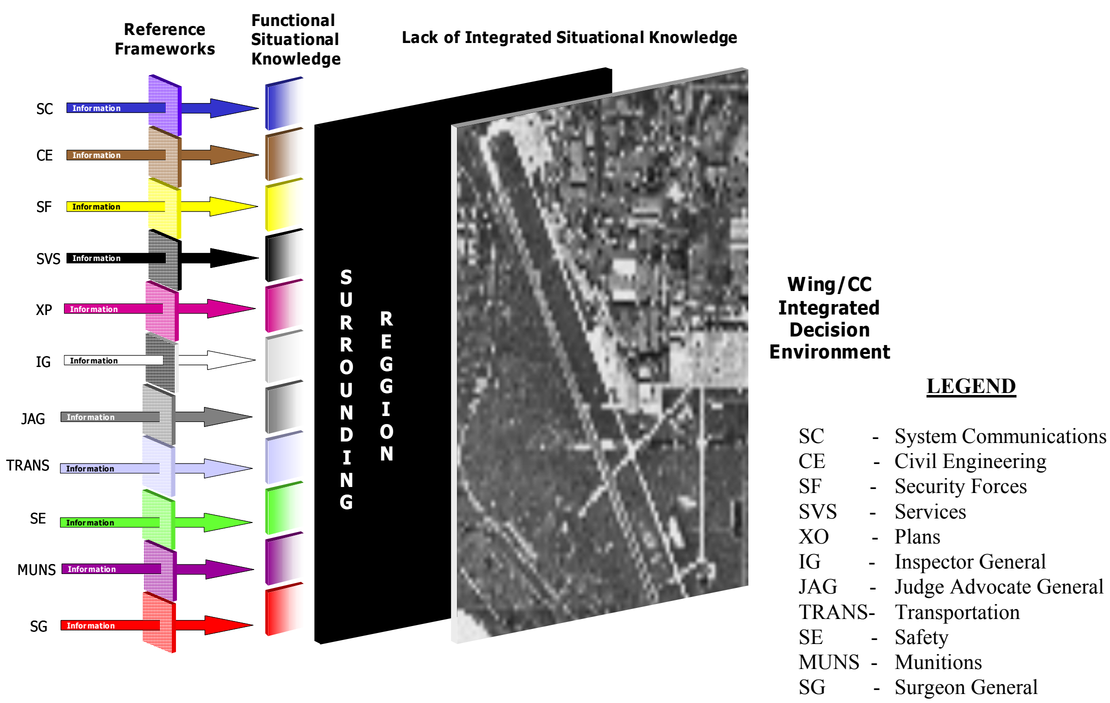
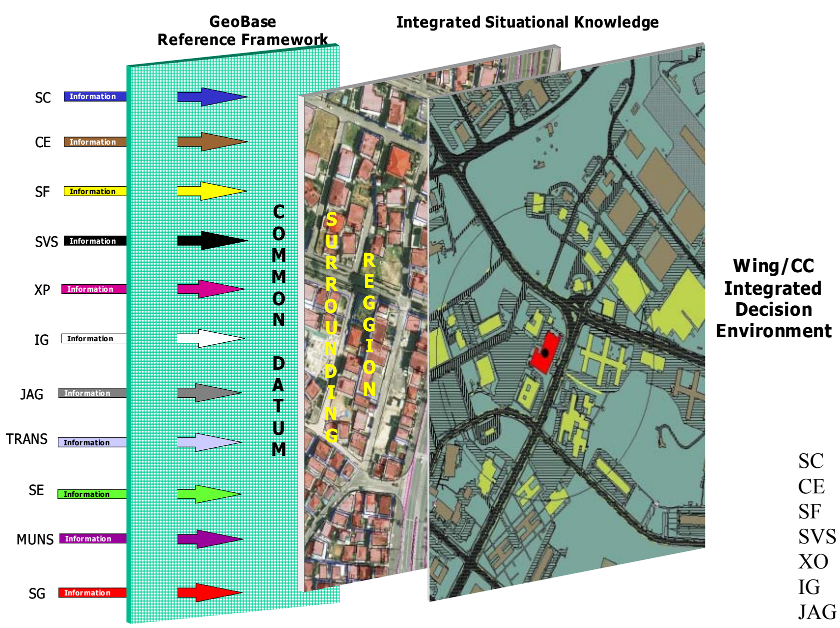


Figure 8: Multiple Perspective of the Mission Situation (5:17)

The CIP concept provides a method of displaying different functional and surrounding region information from different units in a single georeferenced framework

accessible to everyone, as shown in Figure 9. Decision makers are provided an updated, aggregate view of the surrounding environment. As functional units update their own information, the information is instantly shared among authorized users providing up-to-date, accurate information across the widest spectrum necessary on an installation. As local and state governments use GIS technology, the ability to exchange information between the installation and the surrounding community will become available, especially in crisis situations. Through local area networks and the World Wide Web, GIS information can be shared virtually with anyone. A benefit is that everyone involved will be using a common geospatial framework, or what the Air Force has called GeoBase.



LEGEND

SC - System Communications
CE - Civil Engineering
SF - Security Forces
SVS - Services
XO - Plans
IG - Inspector General
JAG - Judge Advocate General
TRANS- Transportation
SE - Safety
MUNS - Munitions
SG - Surgeon General

Figure 9: Common Installation Picture (CIP) (5:18)

GeoBase

In 1998, representatives from the Communications and Information community met with Civil Engineer agencies to explore how the functional missions could better share geospatial information. The results of this meeting produced the USAF GeoBase Initiative (20:1-2). GeoBase uses a different approach than previous technology investments by introducing geospatial information resources (both data and technology) to the command echelon as a vital Command and Control (C2) mechanism in support at the base level (29). The overall goal of GeoBase is to provide each installation "the organic capacity to access, exploit, and maintain one geospatial information infrastructure supporting multiple mission needs" (20:2).

Using commercial-off-the-shelf (COTS) computer hardware and software, GIS technology, and an intranet or internet, GeoBase was developed to bring the CIP to an installation. GeoBase, like GIS, is a "system", rather than a particular software application. This system integrates multiple data sets from different sources into a common architecture using proven geospatial technology.

Potential uses of GeoBase on an installation are enormous. GeoBase can be used for everyday mission activates to include facility management, airfield operations, base comprehensive planning, utility and communication management. Emergency personnel can quickly identify crisis areas, develop cordons, track evacuations and re-route traffic flow. All base personnel would be working from the same data, minimizing inaccuracies from different information. Another significant benefit is the updating of information to all personnel on a real-time basis. As existing conditions change, the information can

change with it, providing more accurate information to all users and decision-makers. Figure 10 shows a screenshot of an emergency response tool being used in a bomb threat scenario at Kadena AB, Japan. This tool can provide numerous types of information. The security forces can use this tool to develop a cordon, track the evacuation of the facilities within the cordon distance, choose an Entry Control Point, and re-route traffic as necessary. The civil engineers can locate and shut down any utility lines. Simultaneously, the wing commander can be shown all these developments using the same tool, thus providing high situational awareness.

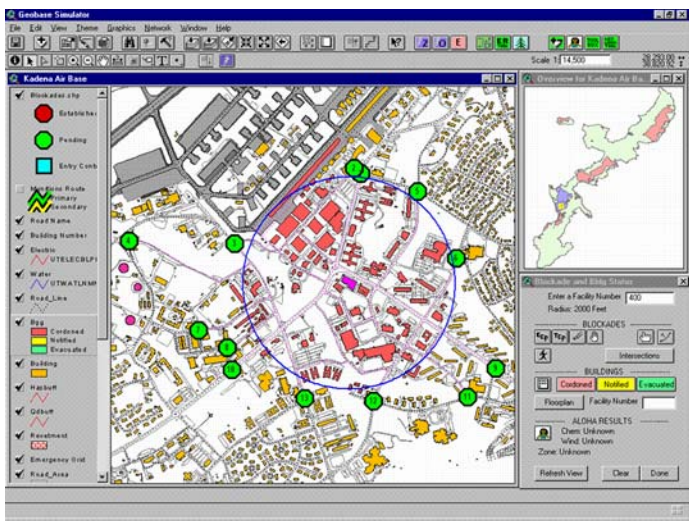


Figure 10: Common Installation Picture (CIP) (5:18)

Summary

This chapter discussed various topics related to the Air Force's application of the GeoBase concept in an effort to provide a background for the research effort. Topics included: Air Force organizational structure, different missions of the major commands

and their effort on GeoBase requirements, satellite and aerial imagery, and a brief discussion of how GeoBase could be used on Air Force installations.

III. Methodology

Introduction

The purpose of this chapter is to describe the research methodology that was used to construct and validate a predictive model which will evaluate the amount of change on an Air Force's installation to its imagery. One question in maintaining a GeoBase plan on an installation is how often to refresh the imagery. As time progress, installations change their footprint through new construction, demolition, land acquisition and many other reasons. Since the imagery is not altered to reflect changes to the installation, the imagery increasingly becomes more inaccurate with every change. A predictive model can be used by installations, MAJCOMs, and HQ USAF to quantify the amount of change of an installation in comparison to its imagery. Second, a predictive model provides the ability to determine the changes value given an installation's forecasted changes. Thirdly, this model can be used to compare the amount of changes of different installations across the Air Force with respect to their missions. The development of the model followed a multi-step approach to problem solving.

Effective problem solving follows a sequential series of steps. There is no single method to problem solving and many variations of problem solving steps exist. The proper method or approach used to solve a problem depends on many factors. These factors include the nature of problem, capabilities and restraints of the problem solver, time and resources available to solve the problem, etc. This research uses a logical sequence of steps to solve the research problem. These seven steps are (28):

1. Define the Objective
2. Information Gathering
3. Prepare Data for Modeling
4. Select and Transform the Variables
5. Process and Evaluate the Model
6. Validate the Model
7. Implement and Maintain the Model

While the steps follow an identified sequence, iteration of the various steps occurred when there was insufficient evidence to complete a given step.

Problem solving can be broken down into two distinct categories, qualitative and quantitative. Qualitative problem solving methods generally rely upon the collection and manipulation of subjective or expert generated data. On the other hand, quantitative problem solving focuses on the collection and manipulation of empirical or objective data. In this research, a quantitative approach was determined to provide a more objective method for determining the relative change in the imagery with respect to the particular installation and their mission.

Many factors are involved in determining when an installation refreshes the imagery. A model that provides information about the change to the image must incorporate all the relevant factors to an installation to be an effective tool. The methodology used in this research attempted to capture, weight, and show the relationships of all the relevant factors on installations across the Air Force. Each step is explained to document the logical process used in developing the model.

Define the Objective

The first and most important step in solving any problem is defining the objective. In many cases, the symptom or symptoms of a problem are addressed, not the underlying cause. Defining the objective involved three steps. First, adequate background information in the general area of the problem and in any area which may be needed to solve the problem is required (19: 24). Second, determine the problem structure. Different techniques are used to solve different types of problems. Third, perform a constraint analysis. Given the available time, resources, manpower and data constraint, the problem objective should reflect these constraints.

Adequate Background

As stated in Chapter 1, imagery is essentially a picture of an area at a specific point in time. This picture provides a visual depiction of all built-up features of an installation, in other words, any physical natural or man-made features that exist on an installation. Installations are constantly altering their installation footprint. Each year, every installation executes a number of projects affecting an installation's real property. Examples of situations which would alter the installation's footprint include construction projects, demolition projects, changes in the natural environment (tree clearing etc), or land acquisition. Other examples exist that would alter the installation's footprint. Currently, the schedule of refreshment is based on a fixed number of years. Unfortunately, a fixed number of years do not address different rates of change to an installation. Different installations will alter their footprint at different rates. Additionally, the same installation may alter its footprint differently over the same two

periods. Due to variable rates of change, a method of evaluating the total amount of change is required to effectively determine when to refresh the picture.

Determine Problem Structure

Installations, in determining the requirement for refreshment, need a quantifiable and justifiable method in calculating the amount of change that has occurred to the installation since the imagery was acquired. To produce a quantifiable and justifiable number, an objective observation method for obtaining data must be used. The next step is to determine what to do with the data.

Models are an effective method for portraying some aspect of reality. A model is a simplified representation of some aspect of reality. Models are simplified because they cannot completely represent the true environment in its entirety. Entering hard data into a predictive model will produce a quantifiable value. A valid predictive model will produce a justifiable and reproducible model that can be used across different installations.

Constraint Analysis

The last step in problem definition was constraint analysis. Different constraints exist in the GeoBase environment. First, not all installations are at the same level of GeoBase adoption. Certain installations are far more advanced than others. Some installations do not have a GeoBase program. Consequently, data will be limited to only those installations with a GeoBase presence. Second, the overall experience of GeoBase at many of the installations is limited. Since many installations do not have GeoBase, personnel will not have experience in how GeoBase will be used at their installations.

The main objective of this research was to develop a quantitative model that produces a value representing the amount of change to an installation when compared with its imagery. Secondary objectives of the model refer to its sustainability. An effective model must be justifiable, verifiable, and understandable for GeoBase personnel. Another secondary objective include ease of use, compatible to current Air Force systems without a reliance on any single system, and expandable to meet the ever-changing GeoBase environment.

Information Gathering

A must for all problem solving is reliable and accessible information. Different types of data exist in the GeoBase environment. Hard, or empirical data, exists in the form of square footages, dollar values of facilities, and numeric information about a facility etc. Soft, or expert data, exists in the form of resident experts of GeoBase on a particular installation. Problem solving is an iterative process, which is clearly shown by this step.

Information was collected in two stages: information search and information collection. A search of the available information was required to determine what information exists on an installation that is available to develop the model. The second stage involved gathering data sets from different installations to be used in developing and validating the model. This information was collected from different installations that have a running GeoBase program.

GeoBase Laboratory

Training on GeoBase, GIS, imagery, and other information is necessary before collecting the research information. Therefore, a GeoBase laboratory was constructed for increasing GeoBase knowledge. The laboratory served two purposes: increase the understanding of GeoBase and provide the ability to perform the research. An increased understanding of the GeoBase information before the data gathering phase allowed for more effective structure of the problem and a more applicable solution. The second purpose of the GeoBase laboratory was for the research process. All data received from installations will be entered into the GeoBase system loaded in the GeoBase.

Information Search

The first stage involved researching what type of information was available that could be used in the model. The results obtained in a search of information available on an installation determined the nature of the model. The criteria for information to be determined useful must be accessible, reliable, and justifiable. Accordingly, this information must be available to GeoBase personnel. The reliability of any solution is tied to the reliability of the information. Similar to reliability, the information used must also be justifiable. For the model to produce values that are considered acceptable, the inputted values must also be considered acceptable.

Many different types of information can be used to describe the amount of change to an installation's image. Since a quantitative approach was taken to model the amount of change, information for the predictive model must also be quantitative in nature. The Resource Flight located in the Civil Engineer Squadron maintains and reports all real

property information for the installation. As such, these records can provide valuable information on what has changed on an installation. Two different types of quantitative information available through real property records are total costs in dollars of all transactions related to real property and total square footages of all built-up features.

One method of measuring changes on an installation is to track the number of dollars spent on any activity that alters the installation footprint. This type of proxy is quantitative and could be used in the model. Every real property acquisition or disposal that occurs on an installation has a specific dollar amount attached to the transaction. As new facilities are constructed, existing facilities demolished or as new land is acquired, these individual dollar amounts can be totaled providing an overall dollar amount. This value represents the total number of dollars spent on all real property transactions during a specific time period. This figure can then be normalized using the installation's Plant Replacement Value (PRV) to provide a value representing change during a specific period. An installation's PRV is calculated on the cost to replace the current physical plant (facilities and supporting infrastructure) using today's construction cost and standards. A PRV is calculated for every Air Force installation.

The other main quantitative type of information available is square footage. As new facilities are constructed or land is acquired, square footage is added to the total square footage of all the installation's built-up features. Similarly, as features are demolished, the square footage decreases the total square footage of the installation.

Information Collection

The second part of information gathering is collecting the data sets from different installations. The different sets of information were identified from the available information at the installation. Only installations advanced in GeoBase adoption were used to collect the information. Every installation in the Air Force is at a different point in the GeoBase adoption process. Primarily, two major commands lead the Air Force in Garrison GeoBase adoption. They were the first to start adopting GeoBase before the other commands. Every installation within the PACAF command has an operational GeoBase program. Although these bases are still developing the GeoBase program, each installation is mature enough to provide useful GeoBase information. A small handful of bases within AMC have a mature enough GeoBase program to provide sufficient GeoBase information. The other commands only have a base or two that will be have enough data to be useful.

Three groups of information were collected from the installations. The first set of data was the imagery. The current imagery used by the installation was requested. The second set of information is the Common Installation Picture (CIP). Only certain layers of the CIP were requested, including those containing facilities, streets, airfield pavements, names and facility identification numbers, and any other built-up features. The last set of information will be a list of facilities that have been constructed, added on, or demolished since the imagery was acquired.

Prepare the Data for Modeling

Preparation of the data included collecting and organizing the data so that it could be used to develop and test the model. Since the available number of installations that can provide GeoBase information is located mostly in only two major commands, this small set represents only small portion of the Air Force. The available information was primarily concentrated in PACAF and AMC because of the limited availability of information. Since these installations do not represent a valid or reliable statistical sample, they should not be considered a true representative of all Air Force installations.

Due to the large size of the files, every installation sent data on compact discs (CD) through the mail. Information from each CD was downloaded onto a laboratory computer. Two of the information sets, CIP and imagery, was accessed using ArcView 8.2®. The third set, facility information, was inputted into a Microsoft Excel® spreadsheet and organized with the other installation's facility information.

Select and Transform the Variables

The structure of the problem determined the structure of the decision tool. Different decision tools are used to solve different types of problems. Three decision tools are explored to establish an appropriate tool to be used in this research. A brief explanation of each tool is provided below.

Decision Trees

A decision tree is a type of graphical representation of decision options, costs, benefits, and the probabilities of important uncertainties to allow an evaluation of

different decision alternatives. Decision trees display visually, the structure of the decision and the relationships involved between the present decision, future events, outcomes, and future decisions. A decision tree may contain two types of nodes: decision and chance nodes. The decision node represents all available options to the decision-maker, while the chance nodes represent all the possible outcomes of a particular event.

A decision tree can be a valuable tool displaying a decision problem when more than one decision must be made or when events with different possible outcomes and different probabilities of the outcomes exist. Additionally, a decision tree contains sequential decision-making. Decisions follow events or other decisions and conversely, events can follow decisions or other events. Accordingly, a decision tree is not a good model to use in determining a value of change in the imagery of the base.

Decision Matrix

Another decision model used when faced with different alternatives is the decision matrix. The decision matrix can facilitate the choice of an alternative that best suits the decision-maker or the situation.

One characteristic of a decision matrix is that it requires a detailed analysis of each alternative. The detailed analysis of the alternative must include all the criteria and the associate weighting of the criteria from the decision-maker's perspective. This can become an involved process requiring the matrix developer to know all the possible outcomes (19:120).

After each alternative has been identified and sufficiently understood, a decision matrix can be used to determine the best alternative (19:120). As the number of alternatives increases, the effectiveness of the matrix increases. The decision matrix is not an appropriate decision aid to use in obtaining different value due to the inherent difficulty in determining all the possible alternatives.

Mathematical Model

Mathematical modeling, a process of creating a mathematical representation of some phenomenon in order gain a better understanding of that phenomenon, can be used to describe change of an installation's imagery. Modeling is used to represent reality or actual conditions graphically or mathematically. Modeling is typically used to describe conditions or situations, predict outcomes of events, or help explain particular phenomena. Fundamentally, any system is composed of two elements (23:1):

- entities that have certain qualities and properties
- relationships and actions that explain how these elements interact and change

Mathematical models use mathematical equations to represent important relationships among components of a system. Mathematical models allow a decision-maker to study and understand the relationships of the essential elements of a system in order to gain a better understanding of the system.

A mathematical model can be used to determine the amount of change at an installation from its imagery at any point in time. For example, the mathematical model can produce a value to describe the amount of change to date. By inputting forecasted

changes, the model will predict the amount of change at some point in the future. Considering the benefits of this type of model, a mathematical model was chosen for this research.

The formulation of the equation was accomplished next. The data sets collected from the various installations was used to develop the model. Variables and constants are defined using the data collected. The relationship of all the variables and constants was defined in this step. Examples of built-up features that can alter an installation's footprint are facilities, natural terrain, natural disasters, and large-scale emergencies. Different ways exist to measure these examples. Quantifiable methods include dollar value and square footage. Qualitative methods include priority and risk.

Using money as a method for measuring change has drawbacks. The total cost of the facility is typically based more on its function than its size. Since the main product in GeoBase is increased situational awareness, the facility value does very little to add awareness to the decision-maker. For example, a computer network facility requires stringent heating and air conditioning conditions, increasing the cost of that facility over other facilities of the same size and shape. When a decision-maker is looking at a base map to assess a particular situation, the dollar amount attached to a facility is not an issue. Therefore, cost was not used in this research.

This research proposes two groups of variables. The first group of variables will represent the facility's square footage. The second group of variables will represent the facility's relative importance to the mission. For example, a newly constructed dining facility may have a total square footage of 100,000 SF. The total square footage of the facility will be the value for that variable. Another variable attached to this facility is the

priority variable. A value will be assigned to this variable based on the importance of this facility to the mission. The relationship of these variables to each other will be determined in this step.

Valuing a built-up feature in terms of risk was explored. Three key questions were raised on the subject of risk of a built-up feature.

- What type of risks is posed by the feature?
- Who is affected by this risk?
- Is risk taken in account in a priority listing?

Each facility poses different risks under different circumstances. Certain facilities pose increased risks under a crisis. A bomb located near a POL tank increases the risk to personnel and resources. Whereas, a generator building only poses a risk to the mission, when base experiences a power failure. Although different risks exist and different areas are affecting by risks depending on the particular situation, risk should be taken into consideration. The research proposed that mission priority reflects the amount of risk to a facility. No existing process or guidance was found to evaluate a facility's risk to the installation.

Process and Evaluate the Model

Each installation acquires, uses, and disposes of land and facilities to accomplish their distinct mission. Certain natural and built-up features have more impact to particular mission than other features. Since missions differ from installation to installation, features, which are more important also, differ. This step assigned values to the second group of variables, the priority variable. The installation's priorities

encompass the primary mission of the installation. Each installation requires different facilities to accomplish the mission. Within all the facilities an installation uses to fulfill the mission, certain facilities have more impact than other facilities to getting the job done. To capture the importance of a facility, it is proposed that a weighting value should be assigned.

A method of assigning weights, which correspond to the priority of the feature according to the particular installation, was proposed as part of this model. After data collection, metrics and base priority listings was explored in an effort to produce a categorization process to capture an installation's priorities in the model. An assignment of the actual weighting values was determined in the sixth step, Process and Evaluate.

A brief discussion of the main facility categorization systems currently used on installations is appropriate in this step to explain which systems were evaluated and chosen for the model. Three different classification systems were evaluated in this research. They are the Installation Readiness Report (IRR), the Facility Investment Matrix (FIM), and the Base Priority Listing (BPL). Existing classification systems were selected over attempting to define a new priority system. Reasons include acceptance from Air Force personnel, ease of use in using existing systems, and increase sustainability when tied to existing systems. Existing systems are currently being used by Air Force personnel, have been accepted for use, and will lessen the amount of new material the user must learn. The following paragraphs will describe each process and how it may be used to construct the predictive model.

Installation Readiness Report.

The IRR provides objective and timely information on the capability of installations and facilities to support forces in the conduct of their mission. The IRR uses facility classes to group like facilities into the nine shown below:

- Operations and Training (airfields, radar, fuel storage, fire station)
- Mobility (Air Freight/Passenger terminal, Deployment and Depot Processing)
- Maintenance and Production (Aircraft and vehicle maintenance and repair)
- Research, Development, Testing and Evaluation (Labs, research, wind tunnel)
- Supply (vehicle fuel storage, solvent storage, supplies and equipment sheds)
- Medical (hospitals, clinics, medical laboratory)
- Administrative (headquarters office, command staff offices)
- Community and Housing (dining hall, education center, base laundry, schools)
- Utilities and Ground Improvements (utility plant, road, sidewalk, land)

Within the Air Force, additional emphasis is placed within the Community and Housing category. This IRR class is further broken down into three subcategories: Community Support, Military Family Housing, and Dormitories (11:2-3).

The nine facility classes do not necessarily correspond significantly with the primary mission of an installation. For example, classrooms are placed under the operations and training category. These classrooms are considered part of the primary mission in AETC, but not PACAF. The emphasis on these classrooms will differ based on the mission of the installation. Therefore, a method of placing emphasis on particular categories must be available. Another example is research and development facilities. Within AFMC, an installation's primary mission may be research and development and accordingly place a higher emphasis on a research facility than an ACC installation.

Consequently, a weighting system must be used to prioritize the categories according to the individual installation. Due to the similar nature of missions within a MAJCOM, a common weighting system could be done at this level.

The research model uses the categorization process employed by the IRR. Each facility that may be considered by the model is assigned a category code and subsequently assigned to one of the IRR categories identified in the Category Code Mapping to IRR Facility Classes (11:22-36). For example, Control Tower is assigned a category code of 149962. This category code is one of the category codes assigned to the IRR category Operations and Training. Every facility in the Air Force inventory is assigned a category code based on the function of facility. The facility's category code determines the IRR category. Table 1 identifies a small sample of the category code mapping. The first column is the category code of the facility. The second column provides the IRR category based on category code. The nomenclature column identifies the main function or description of the facility.

Table 1 Category Code Mapping to IRR Facility Class

CATEGORY CODE	CATEGORY	NOMENCLATURE
690252	Administrative	BILLBOARD
690432	Administrative	BASE FLAG POLE
690625	Operations & Training	TROOP SHELTER
690792	Administrative	COVERED REVIEW STAND
690795	Administrative	OPEN REVIEW STAND
690798	Administrative	STRAY ANIMAL KENNEL
710000	Housing	FAMILY HOUSING
711000	Housing	DWELLINGS

Facility Investment Matrix

The main purpose of the Facility Investment Matrix (FIM) is to improve the existing facility and infrastructure restoration and modernization requirements funding process. The FIM uses a different categorization process than the IRR. Although this research does not involve restoration or modernization of facilities and infrastructure, the categorization process of the FIM could be used to group all Air Force facilities into similar categories. The FIM categorization process was not chosen for this research.

The Facility Investment Metric (FIM) is a management tool used by the Air Force for advocating funds for facility/infrastructure repair and minor construction requirements. Primarily, the FIM is used to collect project requirements and stratify them by two classification systems: mission impact and mission area. Annually, the FIM data is collected from the Automated Civil Engineering System (ACES) at the end of the fiscal year. ACES is an Air Force installation management tool using an Oracle-based database to manage different installation requirements. The repair and construction requirements identify projects that require funding. The FIM allows a method for requesting funds to execute an installation's repair projects.

Each requirement is classified according to the mission impact of not completing the project. The Mission Impact of the requirement is rating into three categories: Critical, Degraded, or Minimal. The determination of the rating is based on the requirement's impact to the particular mission of the installation. Each rating has its own set of requirements that must be met before that rating can be given. A requirement can be assessed any rating regardless of the assignment to a mission area.

The other part of the FIM is the classification of facilities into one of four mission areas. The mission area is determined by the facility's category code. The four mission areas are:

- Primary Mission
- Mission Support
- Base Support
- Community Support

Each of the mission areas represents a main function of a facility to the installation. Since missions may differ between installations, a facility on one installation may be assigned a different mission area if located on a different installation with a different mission. For example, a flight-training classroom is assigned Primary Mission under a Training Wing, but otherwise assigned Mission Support.

Base Priority Listings

Each installation maintains a base priority listing (BPL). This priority listing is installation specific and rank orders a certain number of facilities according to the installation's priorities. Unfortunately, two major factors prohibiting the use of this priority listing in this research effort is the lack of a comprehensive list and a different focus of the rankings (27).

First, the list that is maintained at the wing level contains only a portion of the total facilities on an installation. Subsequently, the remaining facilities are grouped into the same category regardless of how they may differ in importance. The second major factor is the purpose of the list. The primary use of a base priority listing at one base may be different from another base. Regardless of the installation's purpose, the BPL was not

created for the GeoBase program. Some installation's base priority listing incorporates the condition of the facility and any attached construction proposals. These lists may have been developing with certain constraints including resources, time, or political preference (27). As a result of all these limitations, the installation's base priority listing was not used in determining the coefficient weightings.

Validate the Model

The validation process is vital to provide sufficient credibility to a model. Validation was accomplished using the information from the different installations. Each installation contained a different set of data and tested the model for use by different installations. Successful use of the model at installations from different commands validated the model.

Implement and Maintain the Model

Implementing and maintaining of the model will be the responsibility of the units utilizing GeoBase and their MAJCOM. The first step in the implementation stage is development of a reporting process, weighting values, and report format by the MAJCOM. The second stage involves the installation developing the report to provide to the MAJCOM.

The decision-maker must determine the requirements of the reporting process before the installations can produce the report. The reporting process should include the report format, guidelines, and weighting values. This reporting system will assist in the

decision-making process. A report format to be used by the installation is proposed in Chapter Four.

The installations are responsible for following the reporting process. After the weighting values are provided by the MAJCOM, the installation can develop a report. The report should include the change value, list of changes, imagery map and purpose section.

Summary

This chapter presented a description of the proposed methodology needed to construct a predictive mathematical model to measure the amount of change on an Air Force installation to its existing imagery. The methodology used a seven-step process to help solve the problem. A discussion of what information was needed to construct the model was given, along with guidelines that would be used to determining which information will be used. Three different classification systems (BPL, FIM, and IRR) for an installation's facilities were described to provide the benefits and limitations of each. The chapter also describes what type of model was used to solve the problem quantifiably and provided a brief explanation on how the mathematical model was developed. The rest of the chapter further described the remaining steps used in the process.

IV. Analysis

Introduction

The purpose of this chapter is to describe the application of the methodology described in Chapter Three, discuss the information that was obtained, and explain the analysis. The overall goal in this process is to provide a decision tool to assist in determining imagery refreshment at an installation. This type of decision tool chosen is a mathematical model.

A seven-step approach was taken to develop the model. As stated in Chapter Three, there is no single method to problem solving, rather variations of a basic set of steps. The method or steps are determined by the available information, the goal of the model and other factors. For this model, a seven-step approach was taken. Two of the steps were altered due to the limitations of the available information and the purpose of the research effort. These seven steps are:

1. Define the Objective - Completed in Chapters One and Three
2. Information Gathering
3. Prepare Data for Modeling
4. Select and Transform the Variables
5. Process and Evaluate the Model
6. Validate the Model
7. Implement and Maintain the Model

Information Gathering

The development of some models requires the gathering of data. Since the nature of this model is quantitative, quantitative data was required. The data gathering process used in this research can be broken down into two stages:

- Information search
- Information collection

Information search involved investigating the different types of information available at the installation, which may be useful to develop the model. The second stage involved gathering the data sets from identified installations that would be used in developing and validating the model.

GeoBase Laboratory

A GeoBase laboratory was created to provide a central location for GeoBase learning, data storage, and data manipulation. All imagery and CIP layers files collected were stored on one computer. This computer served as the main point for working on GeoBase. Initially, the computer served as a learning center providing a hands-on tool for applying newfound knowledge about GeoBase. The second use of this laboratory was the storage and manipulation of the installation's files. The computer was used to identify changed features to the installation and presented as a layer. This layer provided a visual representation of the various changes to the installation, when shown with the installation's primary layers and imagery.

ArcView® 8.1 was the software tool used for viewing and handling the GeoBase information. The technical capabilities of the computer system were dictated by the software used to view the GeoBase information.

Minimum hardware requirements:

- Pentium, 450 MHz (650 MHz or higher recommended)
- 128 MB RAM (256 MB RAM recommended)
- 693 MB NTFS or 754 MB FAT disk space available
- 50 MB of free disk space on same drive where the "winnt/system32" folder
- Open GL card and 256 MB RAM are highly recommended for evaluating the ArcGIS 3D Analyst extension

Minimum software requirements:

- Operating System: Windows 2000 or Windows NT 4.0 with Service Pack 6a
- Microsoft Internet Explorer 5.0 (or higher)

Given the requirements, the computer system used in the laboratory consisted of the following capabilities:

Hardware:

- Pentium 4, 1.60 GHz
- 256 MB RAM
- 40 GB hard drive

Software:

- Windows 2000
- Internet Explorer 6.0

Information Search

A search of the installations that could provide useful information was performed across all the Air Force installations. This was a multi-step process involving

communication with many personnel throughout the Air Force, including HQ USAF Geo Integration Office (office responsible for GeoBase in the Air Force), MAJCOMs, and installation personnel. Different criteria were developed and used as a guideline in the data collection process.

Criteria were developed for testing the usefulness of the information. The criteria included accessibility, reliability, justifiability, and applicability. The development of the model is based on the availability of information at the installation. Accordingly, accessibility is one of the criteria for the information that will be inputted into the model. As with all models, the reliability of the model depends on the reliability of the inputted information. Information can be unreliable because of the information itself or the process used in obtaining the information. Examples of unreliable information and unreliable methods for obtaining the information are explained in detail later in this chapter. A second criterion is justifiability. All the information used in this model must be justifiable. Justifiability of the information and the process used to gather the information must be acceptable by the user for the model to be usable. Lastly, the information must be applicable and beneficial to the development of the model.

The search for available information tried to answer the main question of measuring change on an installation. The search also helped define what changes to the installation were important to GeoBase. The different types of information can be grouped into three categories: GeoBase information, feature information, and installation information. The following paragraphs identify all the information was identified and if the information was used for model development.

GeoBase Information Category

GeoBase information refers to all information that is a product of a GeoBase system. While GeoBase is a system comprised of different components and different information sets, GeoBase does produce products. For example, a base map produced by the GeoBase system would fall under this category. The different types of information in this category investigated were the GeoBase layers and related database information. These two major products of GeoBase have the ability to provide a visual representation of the base and the tabular data behind the representation.

Providing GeoBase information that met all the criteria defined earlier drastically narrowed the available list of installations. GeoBase adoption is at different stages for each major command and at each installation. Accordingly, not all bases have adopted GeoBase to the level needed to provide sufficient information. Only a small number of installations within the Air Force contain sufficient GeoBase information. PACAF and AMC started the GeoBase program before any other major command. Accordingly, almost all the installations used in this research are from two commands. Even between these two commands, the level of adoption is different. PACAF has executed the initial stages of GeoBase at every base, while AMC has reached a similar level at only three of their installations. Factors influencing GeoBase adoption included leadership focus, available expertise, and cost.

Eleven installations were identified as having the sufficient GeoBase information for this research. These installations are listed in Table 2. This list identifies the installation and their MAJCOM. As the list shows, seven of the eleven installations are

in the PACAF command, three installations in AMC, and one from ACC. Barksdale, while still very early in GeoBase adoption, was able to provide imagery and change information. The CIP layers were not available, but the installation was still useful for this research.

Table 2: Potential Installation List

BASE	MAJCOM
Anderson	PACAF
Eielson	PACAF
Elmendorf	PACAF
Hickam	PACAF
Kadena	PACAF
Kunsan	PACAF
Osan	PACAF
Grank Forks	AMC
MacDill	AMC
Travis	AMC
Barksdale	ACC

Within the GeoBase information category, only certain information was determined to be useful. The visual representation of the installation is shown using the Common Installation Picture (CIP). The CIP can contain numerous layers. Each layer shows a type of information. For example, the 'facilities' layer reveals the buildings on the installation, while the 'roads' layers displays the streets. Each installation determines how many and what layers are placed into GeoBase, based on the needs of the installation.

The primary focus of this research is the refreshment of the imagery layer. Accordingly, the installation's imagery was required. Whatever imagery the installation was currently using was requested. Additional CIP layers were still needed to provide a

clear picture of how the installation is changing; therefore a determination of what layers were needed was accomplished. Unfortunately, determining what additional layers would be required became extremely difficult.

Each GeoBase program at an installation may contain numerous layers to display their information, and usually each layer displays a particular theme of information. Consequently, while there are common layers at each installation, there also exist many unique layers at an installation. A general guideline for this research was to include each layer that contained pertinent information about a changed feature. For example, a new facility would change the footprint of the installation. The layer that contains the facility, commonly called the facility layer, was requested of the installation. A layer that did not contain features that changed the appearance of the installation or did contained features located underneath the surface was not collected.

Tabular data is the other part of the information provided by GeoBase. Geodatabases contain the tabular data of GeoBase. Geodatabases are files which contain the map information and the associated quantitative information for each feature. Tabular information associated with each feature can be added to the GeoBase system to include cost, replacement value, dates of construction etc. A search of all facilities constructed after a certain date could be obtained from the tabular data within GeoBase. A major limitation of this information source is the comprehensiveness of the information. Most of the available installations did not have sufficient information about each feature to be used in this research. In other words, certain information about a feature was not available, for example facility construction dates. Another available source of feature information was necessary at the installation level.

Facility Information Category

Facilities are a building, structure, or other aspect, including utility systems, pavements, or land. A set of descriptors assigned to each facility on the installation was collected about each facility. The descriptors are Area, Facility Identification (Fac ID), Category Code, Nomenclature, and Replacement Value. An installation's real property records provide this information.

Area refers to the total space of the facility. The most common unit of measure of space of a facility is square footage. In cases when a different unit of measure was used, a conversion was performed to provide a square footage value. The Fac ID is a unique number assigned each facility. For example, an air traffic control tower may be assigned a Fac ID of 100. Category code is assigned to each facility based on the primary function of the facility. Nomenclature refers to a description of the facility. Following the previous example, air traffic control tower's nomenclature may be control tower. The replacement value is the total cost to replace the facility in dollars.

Environmental Information Category

The third category in the information search was information that did not fall under GeoBase information or facility information. This information was grouped into the third category, environmental information. The environmental information group includes land acquisition/release, environmental conditions, and terrain issues. Certain descriptors are used to describe these changes. Area, nomenclature, and replacement value are used for these types of features. Examples in this category include terrain

altering projects, significant damage to the installation due to a crisis or the purchase or sale of a section of land on the base.

Part of the requirements of an installation is the efficient use of land. In some cases, due to changing missions or personnel, land may be purchased or sold by the installation significantly changing the footprint of the installation. Environmental conditions may consist of changes in bodies of water, foliage, and terrain. Other circumstances that are classified environmental are significant damage to the installation due to a crisis. A crisis may be a storm that causes considerable damage to the installation. This damage will not be reflected in the base imagery and needs to be considered as change on the installation. Other changes can occur to the installation that affects the terrain. A good example of terrain change is a section of land that recently has been cleared of trees. This section of land is considered change and can be measured in area. A description can also be provided for this changed feature.

The Automated Civil Engineer System is one tool that can provide most of the facility and installation information described above. ACES contains different modules. Real Property and Project Management Modules are two modules that can be used to provide the information. The ACES Real Property Module involves a database for each installation and requires authorization for each database. Limited time prohibited the ability to gain access to all the installation's real property module used in the research. The ACES Project Management Module contains information from every installation on one database. Authorization from one installation allows the viewing of all other installation's project management information. Construction or civil engineer service

projects are managed in this module. The researcher was able to obtain other installation's project management information as necessary.

Certain available information was not used in the model. The monetary values of the changed features were not collected nor used to develop the model. All information related to dollar values was not part of this model, for example, plant replacement value for the installation.

Information Collection

The third stage of gathering data involved obtaining actual data from the installations. The information explained in the Information Search section was requested from each installation. Initial difficulties in obtaining the information were due to the lack of a central source of the information. Additionally, similar information from different installations was not always in the same format. These reasons delayed the gathering of the information and the process would need to be streamlined if more installations were to use this model.

The actual information requested from the installation contained several parts.

- Current Imagery
- Primary Layers of the CIP
- List of all facilities that have been constructed, demolished, or new additions since the last base imagery was acquired
- List of all other features that have changed on the installation
- Total square footage of facilities on the installation

Each of the eleven installations provided the imagery that was being used. The age of the imagery ranged from one to five years. In the case of one installation, their

current imagery was less than one year old, so the previous imagery was also sent, which was five years old. The resolution of the imagery differed from installation to installation. Additionally, two installations (Osan and Kunsan) had acquired black and white imagery, while the rest acquired color imagery. For purposes of this research, the level of resolution or the color spectrum was not pertinent to model development.

The file format of the imagery was typically a Mr. SID file. Mr. SID is an imagery viewing program and a specific image format. This specific image format allows for viewing of images among different computer programs. This type of file can be read by the different versions of ArcView®. Due to the larger file size of an installation's imagery, a Compact Disc (CD) was used to send the information.

A newer version of ArcView is currently available, which restricts the viewing of information saved in the newer version by the older version. Files must be saved in certain format to be read by an earlier version. Therefore, an upgrade to ArcView® 8.2 is required to keep pace with the installations.

The list of facilities that have changed on the installation since the most recent imagery was acquired was also requested. Different methods were employed at the different installations to acquire this information. Many installations provided a list of newly constructed facilities produced from an AF 7115 report. An AF 7115 report identifies all facilities and different descriptors. An AF 7115 report filtered only to show facilities after a certain date can be used to show all new facilities since that date. Other reports were used by the installations to identify the different changes.

The different descriptors (Fac ID, Cat Code, Area etc) were required were provided by the installations. The Fac ID, Nomenclature, and square footage are used in the proposed final report. This information can be used to summarize the changes. The Category Code is used to determine which category to place the facility. An explanation of this process will be described later in this chapter.

The demolition of facilities was more difficult to obtain. A central location for the list of demolished facilities was not found during this research. Personnel from the Engineering or Real Property flights were typically sources of this information. The GeoBase program at one installation developed a system for keeping track of demolished facilities as they occurred. As the GeoBase program matures at the installation, this may be the most logical source for demolition information.

An attempt was made to obtain other changes to the installation. These changes may include previously discussed environmental or land changes. This category of information was the most difficult to gather. An installation may change their footprint in numerous ways. Conversations with different base personnel seemed the most effective.

The central point of contact at the installation for this research was the base GeoBase office. The research proposes that the GeoBase personnel use the model at the base level, therefore making all information obtainable by them. In some cases, information was not known or accessible to the GeoBase personnel. For example, the Eielson AFB GeoBase personnel maintained a current list of demolished facilities, but not an accurate list of new facilities. GeoBase personnel requested this information from the Real Property people. In all of the responding installations, certain information was

not maintained by GeoBase personnel. For example, dates of construction and demolition were not maintained in any of the GeoBase files. Due to the small number of changes, Andersen's GeoBase folks were able to provide all the information requested.

Not all installations were able to provide all the information within the time restraints of the research. Other complications included incomplete data information about certain types of change features. For example, one installation tracks all demolished facilities, but the researcher was unable to obtain the dates of each demolition. Without the dates of each change, determining which changes occurred after the imagery becomes harder. Consequently, six installations were used in developing and processing the model. Table 3 identifies the installations and their MAJCOM.

Table 3: Installations used in research

BASE	MAJCOM
Anderson	PACAF
Eielson	PACAF
Kadena	PACAF
Grank Forks	AMC
MacDill	AMC
Barksdale	ACC

The total square footage of the installation was requested of all eleven installations. Only one base submitted a value, but identified the number as not a total value for the installation due to insufficient data. The total square footage of the installation is required as part of the model to provide a comparable value between large and small installations. Accordingly, a source of this information other than the installation was necessary.

A search for a single source of information about all Air Force installations resulted in using the ACES-RP module, located, and operated at Gunter AFB, AL. A report from the ACES-RP module called the FY2000 Amended AF Plant Replacement Value for Installations used to provide the total square footage of the installation. This Microsoft Access® database contains all the real property data about every facility at every Air Force Installation. Different data sets were extracted from this database to develop the total area for specific installations.

Two issues arose from using this database:

- Geographically separated or remote areas of an installation
- Facilities that do not have an area measurement

The density of facilities differs from base to base. Certain bases maintain a vast amount of land and a small amount of facilities, while other bases are just the opposite. In using the total landmass, the large installations are placed at a disadvantage. For example, if two bases have the same number of facilities, but one base has twice as much land, this larger base must have more changes to produce an equal value. For this effort, the calculation of the total square footage of the installation was not calculated.

A difficulty in calculating the installation's total square footage is that some facilities are described using different units of measure other than area. Facilities containing other types of area measurements were converted into square footage. Facilities using units other than area were omitted from the model. For example, an electrical substation is measured in kW was not used in the model. An exception to this rule is Andersen AFB. Since the only change to the installation involved two new fuel

tanks (measured in barrels), the facilities were still inputted into the model to produce a change value. Square footages were assumed to help illustrate the research results.

An attempt to collect any environmental, terrain, or land issues from the eleven installations was unsuccessful. None of the installations encountered any new environmental, terrain, or land issues since the date of imagery acquisition. This may be due to a very small sample of installations and the relative newness of the imagery.

Prepare the Data for Modeling

The process of preparing the data involved two steps: graphical and tabular. The graphical data incorporated the imagery and CIP layers received from the installation. The tabular data involved transforming the change information into an Excel spreadsheet for input into the model.

The graphical data provides a visual representation identifying the changes on the installation. Since the imagery files were sent on a standard image format, no changes were required. Very little change was required of the installation CIP layers. Installations sent their CIP layers as shape files or geodatabase files. Once the GeoBase installation information was acquired, the individual changes were highlighted on the facility layer. This visual reference provides the decision-maker another method of assessing the change. This map contained the highlighted changes is also part of the final report.

Highlighting the changes on a single layer produced some difficulties. Difficulties resulted from inaccurate CIP layers on the installation. New facilities that have been placed on the facility layer can be highlighted easily. If this information was

not added, highlighting the information requires additional information about the facility's location. Demolished facilities are removed from the facility layer and sometimes kept on a different layer. If an installation did not keep a record of the demolished facility on another layer or its location, highlighting the change was not possible for this research effort. Figure 11 shows the digital imagery of the main part of Kadena Air Base. The changes to the installation are highlighted in red.

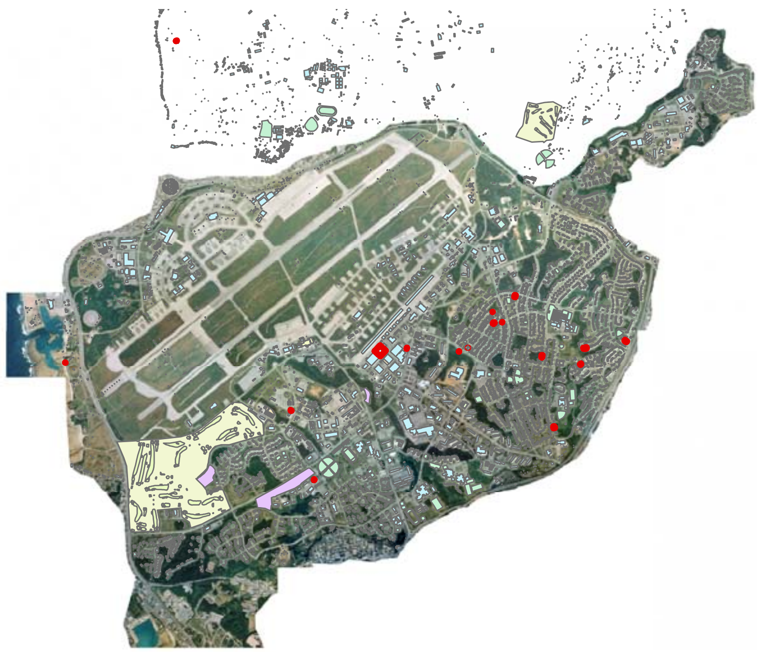


Figure 11: Kadena Air Base Imagery and Changes

Changes to the tabular data involved using an Excel program. The list of facilities identified by the installations came in different formats to include an Excel spreadsheet, word document, and by email. All installation information, including the total area of the installation's features, was inputted manually into Excel. Appendix A

includes a completed Excel spreadsheet for each of the responding installations that identify the list of changed features. This spreadsheet contains different types of information to include FACT_ID_NR, CAT_NOMENCLATURE, RP_AREA_AMT, AREA_UOM, RP_OTH_AMT, OTHER_UOM, Converted SF, and True SF. The FACT_ID-NR column identifies the facility ID number. The CAT_NOMENCLATURE column is the description of the facility. RP_AREA_AMT is the real property area measurement. The AREA_UOM column identifies the unit of measure used in previous column. The RP_OTH_AMT and OTHER_UOM identify an alternative measurement of the facility. The last two columns convert the facilities area measurements to square footages. The True SF column deletes repeated rows of the same facility. The spreadsheet calculates the total area by each category. An example is shown in Figure 12. Note Facility #15 in Figure 12 is listed three times. Real property records track the different functions of a facility. The first time the facility is listed is the dominant function and provides the total square footage. Each subsequent listing is a breakdown of the different functions and square footages within the facility and results in zeros in the True SF columns.

FACT_ID_NR	CAT_NOMENCLATURE	RP_AREA_AMT	AREA_U0M	RP_OTH_AMT	OTHER_U0M	Converted SF	True SF
1	TRAFFIC CHK HSE	63	SF	0		63.00	63.00
3	SAN LATRINE	312	SF	0		312.00	312.00
4	ILS MARKER BEACON	624	SF	1	EA	624.00	624.00
5	SP CON IDENT	64	SF	0		64.00	64.00
7	COMM FCLTY	85	SF	0		85.00	85.00
8	ELEC SWITCH STN	64	SF	1	EA	64.00	64.00
9	ELEC SWITCH STN	25	SF	1	EA	25.00	25.00
10	HQ WG	6,840.00	SF	0		6840.00	6840.00
12	ELEC SWITCH STN	64	SF	1	EA	64.00	64.00
15	LAW CENTER	15,170.00	SF	0		15170.00	15170.00
15	LAW CENTER	14,507.00	SF	0		14507.00	0.00
15	HQ WG	663	SF	0		663.00	0.00

Figure 12: Sample List of Kadena Air Base Facilities

Select and Transform the Variables

The development of the model included identifying the variables and their relationships. The model was developed using the data provided by the installations. The model uses the following information:

- Total square footage of the installation's facilities
- Total square footage of change in each feature category
- The weighting coefficients of each of the categories

Information that was gathered but not used in the model includes:

- Total square footage of the installation
- Replacement Value of facilities or features
- Total Replacement Values of the installations

The mathematical equation developed in this research represents the value of change on an installation. Change Value, denoted ΔV, is given by

$$\Delta V := \left(\frac{100}{T}\right) \cdot W_1 \left(A_1 + A_2 + \;..A_N\right) + W_2 \cdot \left(B_1 + B_2 + \;..B_N\right) + \;..W_{12} \cdot \left(L_1 + L_2 + \;..L_N\right) \quad (1)$$

where

ΔV	=	*Value representing the amount of change to the installation when compared with its imagery*
T	=	*Total square footage of the installation's features*
N	=	*Total number of features that have changed since the imagery was acquired*
Wi	=	*Category Weightings (i = 1 - 10)*
Ai	=	*Operations and Training features (total SF)*
Bi	=	*Mobility features (total SF)*
Ci	=	*Maintenance and Production features (total SF)*

Di	=	*Research, Development, Testing, &Evaluation features (total SF)*
Ei	=	*Supply features (total SF)*
Fi	=	*Medical features (total SF)*
Gi	=	*Administrative features (total SF)*
Hi	=	*Community Support features (total SF)*
Ii	=	*Housing features (total SF)*
Ji	=	*Dormitories features (total SF)*
Ki	=	*Utilities &Ground Improvements features (total SF)*
Li	=	*Environmental features (total SF)*

The constant 100 is used as a multiplier in the equation. Using this number, the change value is a number greater than one, which is easier to comprehend. Using the values determined by the responding installations, a value of 100 was determined to be the minimum number to raise the value above one.

T, the total square footage of the installation features, is used to normalize the installation's value. T is calculated by totaling the square footage of the features on an installation. Examples of features that are used in calculating T are facilities, unusual terrain, and environmental issues. A larger installation with more facilities will have a larger value of T than a smaller installation with fewer facilities.

N, the number of features (facilities, terrain, and environmental) that have changed, represents the number of individual changes that affect the accuracy of the imagery over a period of time. The start of this period is the imagery acquisition date. At time zero, the imagery represents the actual conditions on the installation. Over time, the installation will construct new facilities, change existing features, or demolished features. N, in this equation, represents the number of changes since time zero. For

example, if an installation has constructed two new facilities since acquiring the imagery and no other changes have been made, then N = 2.

The coefficients Ai through Li represent the different changes within each category measured in square footage. Each of the changes within each category is summed to provide a subtotal for each category. Every installation feature was divided into one of twelve categories. The categories are:

1. Operations and Training (O&T)
2. Mobility
3. Maintenance and Production (M&T)
4. Research, Development, Testing, and Evaluation (RDT&E)
5. Supply
6. Medical
7. Administration
8. Community Support
9. Housing
10. Dormitories
11. Utilities and Ground Improvements (U&GI)
12. Environmental

Categories one through seven and eleven are taken directly from the Installation Readiness Report (IRR). Categories eight, nine and ten are subcategories of the Community and Housing category of the IRR. Category twelve contains features from the installation that do not have a category code or that do not belong in one of the other categories.

Each changed feature is placed into one of these categories, typically based on its category code. If the feature has been assigned a category code, then it is placed on one

of the first eleven categories. If not, then the changed feature is placed into the twelfth category. For example, a section of land that has been cleared of trees is placed in the twelfth category since it does not have a category code.

The coefficient W_i represents the category weighting. The value of the category weighting affects the overall change value of the installation. Each installation has a unique mission and uses the existing facilities and features on the installation differently to complete their mission. Accordingly, one category of features may be more important to an installation than a different installation. An installation with a research and development focus may value research facilities more than supply facilities.

The development of the weightings can be done at the installation, MAJCOM, or headquarters level. The benefit of developing the weightings at the installation level is the ability to match the weightings to the specific mission of the installation. A drawback of developing the weights at the installation is the installation's ability to change the weightings to maximize their change value. If the installation has more changes in certain categories, weightings these categories higher than the others provide an advantage. Weights determined by Air Force Headquarters would set a standard value for each of the categories, preventing installations from changing the numbers as they see fit. Unfortunately, one set of weights does not accurate capture the different values of the different installations. Certain categories may contain facilities that directly affect the installation mission. For example, research laboratories are usually more important at an AFMC base than PACAF base. A beneficial compromise is the MAJCOM. Installations under a MAJCOM have similar missions, requirements, and goals. Each MAJCOM sees the overall picture of the MAJCOM, not as a particular installation. Another major factor

is GeoBase funding. The funding for refreshing the imagery will come from the MAJCOMs. Therefore, it is suggested that each MAJCOM should determine the category weightings for their command.

A search for any existing facility weightings or values was performed within Air Force regulations, instructions, and other existing systems. The research did not reveal any existing weighting system for the facilities of a base. Different methods of ranking the facilities exist currently in the Air Force. Base Priority Listings are listings maintained at each installation rank-ordering the top portion of the facilities. The Facility Investment Matrix categorizes each facility and ranks the different categories. Neither method assigns a value to the different rankings. A value of category needed to be developed. The two options included researcher defined or expert defined values.

A weighting system developed by the researcher was explored, but not chosen. The researcher's limited exposure and knowledge of each MAJCOM's mission and priorities hindered the ability to accurately depict the proper weighting values. Second, a researcher's developed values would be static and would not allow the changing of an installation's mission or priorities. A system of developing the weights needed to be adaptable to the changing needs of an installation.

The research used an expert in installation support at the MAJCOM headquarters level to provide information about the importance of each of the categories. Different methods exist for obtaining subjective values. One MAJCOM was chosen to illustrate the process. The PACAF command was chosen due to the advanced GeoBase presence within the command. The expert chosen within the command was the Deputy Civil Engineer, PACAF. The person in this position has the knowledge of the all the

command's installations and the technical background to understand the role and impact of GeoBase on the installation. Considering the availability of time, a long-distance facilitation of determining the values was used.

The expert was asked to answer two questions, shown in Appendix B. An introductory letter was provided with the questions. This letter briefly explained the research effort and the purpose of the questions. The first question identified the twelve categories and asked the expert to rank order the categories in order of importance to the PACAF mission in terms of installation support. Table 4 identifies the ranking of each category according to the expert. The actual responses and comments by the expert are shown in Appendix C.

Table 4: Category Ranking

Rank	Category
1	Operations & Training
2	Maintenance and Production
3	UGI
4	Medical
5	Mobility
6	Supply
7	Community Support
8	Admin
9	Dormitories
10	Housing
11	RDT & E
12	Environmental

The results of this question can be used to understand the relative ranking of each category in relation to each other. There are two drawbacks to using only a ranking system. First, it only provides enough information to state that one category is more important than another category. Information about how much more important is

missing. Second, no two categories can be evenly weighted. Nonetheless, this question helps capture the relationship of each category.

After the ordinal ranking is completed, a method called the Rank-Centroid method was used to determine the weights (22:2). The equation for the Rank-Centroid is displayed below (22:9):

$$w_i = \frac{1}{m} \cdot \sum_{k=i}^{m} \left(\frac{1}{k}\right) \qquad (2)$$

where

w_i = *weight*

m = *number of categories*

i = *1,2,…,m*

Using the rank order provided by the expert, the equation produces the following raw values and weighted values for each category in Table 5. Each raw weight is divided by the lowest raw value to produce weights greater than one. These weights are used to increase the value of each category when it is multiplied against the square footages. For example, the total square footage of changes within the Mobility category is multiplied by twelve.

Table 5: Final Rank-Ordered Category Weights

Category	Raw Value	Weighted Value
Operations & Training	0.26	37
Mobility	0.08	12
Maintenance and Production	0.18	25
RDT & E	0.01	2
Supply	0.07	10
Medical	0.11	15
Admin	0.04	6
Community Support	0.05	8
Housing	0.02	3
Dormitories	0.03	5
UGI	0.13	19
Environmental	0.01	1

The second question asked the expert to place a value next to each category representing overall importance in relation to the other categories (22:5). The expert was forced to score the most important category the highest value, and the least important category the lowest value. All other categories could receive a score ranging from the highest to the lowest values. Table 6 shows the values assigned to each category. The values that are provided by the expert are the weights used in the model.

This direct value method assigned a value to each of the categories. According to the model, each category is multiplied by its weighting value. For example, the total number of square footage of change within the Supply category is multiplied by seven. The purpose of directly assigning weights is to better capture the differences between each category.

Table 6: Category Weights using Direct Value Method

Category	Weight
Operations & Training	10
Mobility	7
Maintenance and Production	8
RDT & E	2
Supply	7
Medical	8
Admin	6
Community Support	6
Housing	3
Dormitories	6
UGI	8
Environmental	1

A third option for weighting the variables was added to help evaluate the need for weightings. The third option entails equally weighting each category. In essence, weighting each category resulted in no category weightings. For purposes of producing similar values to the other weighting options, a value of five was used to weight each category.

Process and Evaluate the Model

An Excel spreadsheet was used to input the changed features, the installation's total features, and to calculate the changed value, or ΔV of all six installations. Appendix A provides the list of each installation's changes. A summary of each installation is provided along with the results comparing the three different weighting methods. The different weighting methods produce different change values and in some cases, the order of the installations changes depending on which method is used.

Individual Installations

Kadena Air Base is the first PACAF installation used in this research. This installation's imagery was acquired in 1997. This installation had the oldest imagery of the group. With 1,242,319 square feet of changed features, the changed values ranged from 20.9 to 46.4.

Table 7 summarizes the changes and the corresponding change values based on each of the weighting methods. The square footage subtotals of each category are identified in the SF column. The three different weighting methods are identified along with the resulting category values. Each of these category values is summed and located under each category column. These values are divided by the total square footage of the installation's facilities and multiplied by 100 to produce the change value.

Table 7: Kadena Air Base

		RANK-ORDERED		RATIO-SCALE		EQUAL	
	SF	Weight	Total	Weight	Total	Weight	Total
Operations & Training	68524	37	2551733	10	685240	5	342620
Mobility	0	12	0	7	0	5	0
Maintenance and Production	66356	25	1674728	8	530848	5	331780
RDT & E	0	2	0	2	0	5	0
Supply	67119	10	660352	7	469833	5	335595
Medical	248830	15	3791803	8	1990640	5	1244150
Admin	14921	6	91380	6	89526	5	74605
Community Support	278939	8	2186471	6	1673634	5	1394695
Housing	0	3	0	3	0	5	0
Dormitories	461171	5	2132567	6	2767026	5	2305855
UGI	36459	19	701419	8	291673	5	182296
Environmental	0	1	0	1	0	5	0
Delta SF Total			13790452.81		8498419.828		6211595.517
Total Installation SF			29714309.00		29714309.00		29714309.00
X 100			0.464101414		0.286004289		0.209043916
Delta Value			46.41014137		28.60042893		20.90439161

Andersen Air Force Base is a PACAF installation with only two changed features, both in the same category. The imagery was acquired in 2001. A list of facilities of

newly constructed or demolished was provided by the installation. Inputting this changed feature information into the model produced the results shown in Table 8.

Table 8: Anderson Air Force Base

		RANK-ORDERED		RATIO-SCALE		EQUAL	
	SF	**Weight**	**Total**	**Weight**	**Total**	**Weight**	**Total**
Operations & Training	0	37	0	10	0	5	0
Mobility	0	12	0	7	0	5	0
Maintenance and Production	0	25	0	8	0	5	0
RDT & E	0	2	0	2	0	5	0
Supply	200000	10	1967706	7	1400000	5	1000000
Medical	0	15	0	8	0	5	0
Admin	0	6	0	6	0	5	0
Community Support	0	8	0	6	0	5	0
Housing	0	3	0	3	0	5	0
Dormitories	0	5	0	6	0	5	0
UGI	0	19	0	8	0	5	0
Environmental	0	1	0	1	0	5	0
Delta SF Total			1967705.628		1400000		1000000
Total Installation SF			26953326.00		26953326.00		26953326.00
X 100			0.073004186		0.051941642		0.037101173
Delta Value			7.300418611		5.194164164		3.71011726

The only changes to the installation during this time were the construction of two POL tanks. Since these were the only facilities constructed, an assumption was made that the value of the volume (100,000 Barrels) measurement would be used for the square footage. This made the total changed feature for this installation 200,000 square feet (SF). This was only done in this case to supply a value measurement for change. Otherwise, a zero value would provide little value as an example.

Eielson Air Force Base is the third PACAF installation. This installation imagery was acquired in 2001 and the base had experienced 1,174,284 SF of changed features. Inputting the installation information into the model and using the same category weightings and the changed features, the installation's changed value ranges from 23.4 to 42.7. Table 9 summarizes the results of the model for this installation. In this particular installation, the equal weighting was approximately half of the rank-ordered method.

Table 9: Eielson Air Force Base

	SF	RANK-ORDERED		RATIO-SCALE		EQUAL	
		Weight	Total	Weight	Total	Weight	Total
Operations & Training	13102	37	487899	10	131020	5	65510
Mobility	0	12	0	7	0	5	0
Maintenance and Production	10922	25	275655	8	87376	5	54610
RDT & E	0	2	0	2	0	5	0
Supply	19986	10	196633	7	139902	5	99930
Medical		15	0	8	0	5	0
Admin	50211	6	307504	6	301266	5	251055
Community Support	754411	8	5913472	6	4526466	5	3772055
Housing	159174	3	523827	3	477522	5	795870
Dormitories	12995	5	60092	6	77970	5	64975
UGI	153483	19	2952787	8	1227864	5	767415
Environmental	0	1	0	1	0	5	0
Delta SF Total			10717869.62		6969386		5871420
Total Installation SF			25083951.00		25083951.00		25083951.00
X 100			0.427279962		0.277842434		0.234070781
Delta Value			42.72799616		27.7842434		23.4070781

Installation four, Grand Forks, is the first of the two AMC bases used in the research. The imagery was acquired in 2001. Table 10 summarizes the results of the model for this installation. This installation experienced over 1,220,086 SF of changed features. The total square footage of the installation is 16,767,163 SF. Although a different command determined the category weightings, the same category weightings are used for every installation to help illustrate the example. In the actual implementation of this model, each MAJCOM would develop their appropriate category weightings. The installation change values ranging from 34 to 57.

Table 10: Grand Forks Air Force Base

	SF	RANK-ORDERED Weight	RANK-ORDERED Total	RATIO-SCALE Weight	RATIO-SCALE Total	EQUAL Weight	EQUAL Total
Operations & Training	105974	37	3946311	10	1059739	5	529869
Mobility	0	12	0	7	0	5	0
Maintenance and Production	13194	25	333003	8	105554	5	65971
RDT & E	0	2	0	2	0	5	0
Supply	30899	10	304001	7	216293	5	154495
Medical	15287	15	232949	8	122295	5	76434
Admin	9084	6	55633	6	54504	5	45420
Community Support	207328	8	1625143	6	1243966	5	1036638
Housing	719628	3	2368230	3	2158884	5	3598140
Dormitories	108912	5	503635	6	653472	5	544560
UGI	9781	19	188169	8	78247	5	48904
Environmental	0	1	0	1	0	5	0
Delta SF Total			9557074.671		5692952.74		6100431.99
Total Installation SF			16767163.00		16767163.00		16767163.00
X 100			0.569987581		0.339529874		0.363832092
Delta Value			56.99875805		33.9529874		36.38320919

MacDill is the second AMC installation. This installation acquired its imagery also in 2001. Table 11 summarizes the results of the model for this installation. With 535,970 SF of construction and demolition, and 17,917,011 SF of total square footage, the change values ranged from 14.9 to 43.4.

Table 11: MacDill Air Force Base

	SF	RANK-ORDERED Weight	RANK-ORDERED Total	RATIO-SCALE Weight	RATIO-SCALE Total	EQUAL Weight	EQUAL Total
Operations & Training	127287	37	4739981	10	1272870	5	636435
Mobility	0	12	0	7	0	5	0
Maintenance and Production	10830	25	273333	8	86640	5	54150
RDT & E	0	2	0	2	0	5	0
Supply	23289	10	229129	7	163023	5	116445
Medical	23361	15	355987	8	186888	5	116805
Admin	61424	6	376175	6	368544	5	307120
Community Support	141708	8	1110782	6	850248	5	708540
Housing	93971	3	309250	3	281913	5	469855
Dormitories	41904	5	193774	6	251424	5	209520
UGI	9446	19	181727	8	75568	5	47230
Environmental	0	1	0	1	0	5	0
Delta SF Total			7770139.55		3537118		2666100
Total Installation SF			17917011.00		17917011.00		17917011.00
X 100			0.433673873		0.197416745		0.148802722
Delta Value			43.36738728		19.74167455		14.88027216

Barksdale is the only ACC installation used in the research. Table 12 summarizes the results of the model for this installation. This installation executed 710,117 SF of change features to the base. Using the same category weightings, the change values ranged from 15.9 to 28.1.

Table 12: Barksdale Air Force Base

		RANK-ORDERED		RATIO-SCALE		EQUAL	
	SF	Weight	Total	Weight	Total	Weight	Total
Operations & Training	21219	37	790164	10	212190	5	106095
Mobility	0	12	0	7	0	5	0
Maintenance and Production	44661	25	1127178	8	357288	5	223305
RDT & E	0	2	0	2	0	5	0
Supply	20063	10	197390	7	140441	5	100315
Medical	4824	15	73511	8	38592	5	24120
Admin	25166	6	154123	6	150996	5	125830
Community Support	78905	8	618499	6	473430	5	394525
Housing	441059	3	1451485	3	1323177	5	2205295
Dormitories	0	5	0	6	0	5	0
UGI	74220	19	1427884	8	593760	5	371100
Environmental	0	1	0	1	0	5	0
Delta SF Total			5840233.662		3289874		3550585
Total Installation SF			20759236.00		20759236.00		20759236.00
X 100			0.281331821		0.158477605		0.1710364
Delta Value			28.13318208		15.84776049		17.10364004

Installation Comparisons

Table 13 shows the summary change values for each installation. The installations were prioritized based on the change value of the ratio scale results. As the tables illustrates both the direct value and the equal weighting methods produce the same ranking of the installation, even with different values. The rank-ordered method switches Kadena and Grand Forks installations. If the rank-ordered method were used, then Grand Forks would receive the highest change value.

Table 13: Summary Values

	Rank-Ordered	Direct	Equal
Grand Forks	57.0	34.0	36.4
Kadena	46.4	28.6	20.9
MacDill	43.4	19.7	14.9
Eielson	42.7	27.8	23.4
Barksdale	28.1	15.8	17.1
Anderson	7.3	5.2	3.7

This prioritized list of installations provides information about the relative changes to the installation when compared with each other. The fact that Andersen AFB has only constructed two new facilities explains the low score on Table 13. The priority ranking may change if the weighting method is changed. For example, using the rank-ordered or equal method would switch MacDill and Eielson in the list.

Table 14 compares the age of the imagery with change value using the rank-ordered method. Using age as a criterion places Kadena and Barksdale on the top of the list. According to the model, Barksdale falls fifth on the list. Grand Forks is another interesting example, because it has the newest imagery, yet is on top of the list. This is due to the amount of changes that have occurred on the installation in the last two years.

Table 14: Age versus Rank-Ordered Value

Installation	Rank-Ordered	Age (years)
Grand Forks	57.0	1.33
Kadena	46.4	5.00
MacDill	43.4	1.80
Eielson	42.7	1.75
Barksdale	28.1	5.00
Anderson	7.3	1.80

Decision-makers at the MAJCOM level can determine which installations have experienced more change. This information can be used in assisting the decision of which installation should refresh its imagery. It is suggested that these values represent only part of the information sent from the installation to the MAJCOM.

A second benefit of the model is for future predictions. An installation can input future changes into the model to determine a new change value. This ability provides for planning and budgeting abilities.

A determination of which category-weighting method is optimal due to the different rankings based on which method is used. Each method has its advantages and disadvantages. The equal weighting method is simple and easy, since no weighting is assigned to a category. The disadvantage is that all facilities or changes are treated equally, which may not accurately represent the installation mission requirements.

The rank-ordered method provides the most impact by the decision-maker to the process. Each MAJCOM can directly assign a value to each category, which represents the importance of that category. Normalizing the values makes the values comparable with other MAJCOMs. This method, while providing the most impact to the decision-maker, is also the most complicated of the three methods. A thorough explanation of this weighting system and the impact of assigning different numbers to the categories must be fully understood by the decision-maker.

Determining the category weights is easier to the decision-maker in the rank-ordered method over the direct value method. In the rank-ordered method, the decision-maker only ranks the categories, but does not indicate their relative values. This is a limitation of the weighting system as it limits the impact of the decision-maker to the

process. The benefits of using this method are ease of use, objective weighting system, and comparable values. Each MAJCOM can easily rank order each category without having to assign a specific value, thus eliminating the need for understanding the impact of the values. If each MAJCOM uses the rank-ordered method, the process of determining weights is identical at each MAJCOM. The actual weights assigned to the each category position are the same for each MAJCOM. Since the number of categories is the same for each MAJCOM, the rank-ordered method produces the same weights for each ranked position. Table 15 identifies the weights when 12 categories are ranked. For example, the top category will be assigned a weight of 37. The second place category is assigned a value of 25. Accordingly, results can be compared across different MAJCOMs without concern for how one MAJCOM may have rated the different categories.

Table 15: Weighted Values for 12 Categories

Position Rank	Weight
1	37
2	25
3	19
4	15
5	12
6	10
7	8
8	6
9	5
10	3
11	2
12	1

Some limitations of this method are complexity of determining the weights and the restriction in assigning weights. The benefits include uniformity among the

MAJCOMs, and ease of rank-ordering to the decision-maker. It is proposed that the Air Force use this method in determining the weights.

Validate the Model

Model validation is an important step in model development. The validation phase is a testing phase. Validation of this model came from the six installations used in the model.

Implement and Maintain the Model

Implementing and maintaining this model requires a systemic reporting process for effective collection and prioritization of the installation's information. This research suggests developing the reporting process to include two steps. The MAJCOM can be responsible for setting the requirements and the installation can be responsible for fulfilling them. The first step is developing the reporting process and is performed by the MAJCOM. The second step is producing the report and is performed by the installation.

The first step of the process is the reporting guidelines. Since each MAJCOM should be the decision-maker for imagery refreshment funding, it is suggested that they should be responsible for developing the guidelines for their command. The guideline should include the following:

- Weighting values
- Requirements
- Report format

The weighting values should be determined by each MAJCOM. It is suggested that all MAJCOMs implement the rank-order method to determine the category

weightings Air Force wide. A step-by-step instruction on developing the weighting values is provided in Appendix D.

The MAJCOM requirements developed by the MAJCOM will provide guidance to the installations. These requirements may include how often to submit the report, the deadlines for submittals, the reporting chain, and the when the MAJCOM will make any decisions for funding imagery replacement.

The report format is developed by the MAJCOM to assist in the decision-making the process. The MAJCOM is responsible for collecting all the reports and using them to make a decision. It is suggested that the report should include four parts: change value, list of changed features, imagery map and a discussion section. The change value is produced by the model. The list of changed features identifies all the changes and provides the decision-maker the ability to review all the changes. The imagery map contains the imagery and only the CIP layers that contain changes to the installation. The changes are highlighted to visually represent the changes to the decision-maker. The last section is the discussion section. The role of the discussion section is to add validity to the change value and justification for any requests by the installation. This section can also identify any special circumstances the MAJCOM should consider in developing their priorities.

Figure 13 illustrates the suggested report format that installations should use to present to the MAJCOM. The report will include the title, installation name, change value, discussion, and identify the attachments. An instruction booklet for the MAJCOM is located in Appendix D. Attachments will include the list of changes and the installation imagery. A sample list of the changes is provided in Figure 14 to illustrate

what information is required. The actual report will contain all the changes to the installation. MAJCOMs may alter the format of the list of changed features to increase the understandability of the information. Figure 11, on page 64 shows Kadena's imagery with the changes highlighted in red.

GEOBASE INSTALLATION CHANGE REPORT
KADENA AIR BASE
(RESEARCH EXAMPLE)

CHANGE VALUE **46.4**

DISCUSSION

Request funding for refreshment of base imagery. A change value of 46.4 justifies refreshment is an effective use of resources. Some important changes to the installation include:

1 Approximately 500K of construction of dormitories
2 Over 50K of VOQ construction
3 A new Air Freight Terminal, providing mission critical operations
4 A general change on the installation totaling over 1M square feet

ATTACHED

LIST OF CHANGED FEATURES

IMAGERY MAP

Figure 13: Sample Installation Report

A sample list of the changes is provided in Figure 14 to illustrate what information is required. The actual report will contain all the changes to the installation. MAJCOMs may alter the format of the list of changes to increase the understandability of

the information. There are eleven suggested columns in Figure 14. INST_NAME_40 is the name of the installation. Columns two through seven were previously described for Figure 12. RP_CAT_PRES column is the category code assigned to the facility. The type column identifies if the changes are additions or deletions to the installation. YR_COMP identifies the fiscal year the change was completed. The last column, IRR Category is the IRR category based on the category code.

INSTL_ NAME_40	FACT_ID_ NR	CAT_ NOMENCLATURE	RP_AREA_AMT	AREA_U0M	RP_OTH_AMT	OTHER_U0M	RP_CAT_PRES	TYPE	YR_ COMP	IRR Category
KADENA	255	SQ OPS	1,600.00	SF	0		141753	D	N/A	Operations & Training
KADENA	1055	ACFT ARES SYS SPT	0		1	EA	116922	N	1998	Operations & Training
KADENA	45811	SHP CONVL MUN	18,116	SF			216642	N	1999	Maintenance & Production
KADENA	47801	SHP, SRVLL INSP	15,155	SF			215582	N	1998	Maintenance & Production
KADENA	162	HSG SUP-STOR FCLTY	177	SF	0		442769	D	N/A	Supply
KADENA	163	HSG SUP-STOR FCLTY	177	SF	0		442769	D	N/A	Supply

Figure 14: Sample List of Changes

The second step involves running the model and developing the report at the installation level. Instructions for running the model are provided for the installation. Developing the report requires following the guidelines set by the MAJCOM. These instructions serve as guide for GeoBase personnel and may be altered to better suit the needs of the installation. Appendix E provides step-by-step instructions for the installation.

Summary

This chapter described the steps in developing the mathematical model used in this research. A detailed seven-step approach was taken to collect the information,

develop the model, and describe how to implement and maintain the model. A brief description of the tools used in processing the data from the installation was provided.

The data collected was grouped into three categories: GeoBase information category, facility information, and environmental information. This information was collected from six installations, processed, and used to develop a mathematical equation. Part of the mathematical equation involves weighting the different categories of facilities to better capture the facility's importance to the mission. This chapter suggests the most appropriate method for obtaining the category weights. It also suggests guidelines for the MAJCOM's reporting process and the report format to be used by the installation.

V. Conclusions

Findings

The purpose of the research was to develop a quantifiable model to determine change on an installation when compared with its imagery. A quantifiable, justifiable, and logical mathematical equation was successfully developed which captures the amount of change on an installation when compared with its imagery. Six installations were used in developing the model and the results for each installation were determined. Findings are discussed below and include information sources on an installation, development of category weightings, and the level of change for each of the six installations.

The first finding occurred in the gathering of an installation's change information. Difficulties existed due to inconsistencies of the GeoBase related information. The management of facility information differed on the different installations. Access to certain information, for example demolished facilities, was not always available to the researcher, or was not easily accessible. Each installation maintains the information required by the model and can sufficiently use the model to develop their report.

Category weightings are used in the model to better represent the installation's mission priorities. Development of the weightings can be done using different methods. Three different methods were investigated and evaluated for this model. The equal weighting method is the simplest method but does not allow for differentiation of the facilities for the installation's mission. The direct value method most accurately represents the mission's priorities if correctly applied. This method allows the decision-

maker to directly weight each category. Unfortunately, the complexity of this method is not suitable to be used across the Air Force without proper training for all the decision-makers. This research proposes that the rank-ordered method is the most appropriate method. This method is simple to understand and provides a uniform method of assigning weights, which more accurately represents the installation's priorities than equal weighting. Chapter Four details the suggested process for implementing rank-order method.

Using the rank-ordered weighting method, the six installations change values were calculated. According to the model, the value of Grand Forks and Kadena were 57.0 and 46.4, respectfully, placing these two installations at the top. MacDill follows these two installations with a value of 43.4. Assumed in this model is that all three of these installations are using the same category weightings. Since these installations belong to different commands, a different value would be obtained when using their own MAJCOM weightings. For illustrative purposes, a prioritization of the six installations can be determined. Using the change values and taking into consideration the changes to the installations, the decision-maker can prioritize an installation list. This list could indicate the order of refreshment. If only a limited amount of funding is available, a strategic plan can be developed.

Calculating the change value without multiplying by 100 produces a decimal number significantly lower than one. Decimal values less than one are not easily communicated among different organizations. For example, a value of 24.7 can be more easily interpreted than 0.247. For these reasons, a multiplier was used. Given the value of the six installations, a value of 100 was determined to be adequate. Since the lowest

installation on the list is Andersen AFB and the changes only include two new facilities, Anderson is assumed to represent the lowest possible value. Based on Anderson's results, 100 was sufficient to produce the desired format of the value.

Recommendations

Decision-makers may use GeoBase for increasing their situational awareness before making a decision. The accuracy of the information directly affects the situational awareness of the decision-maker. The GeoBase environment relies on many different sources of information. One important source is imagery. The decision model proposed in this research can assist in the effective use of GeoBase.

Accordingly, this research recommends one implementation strategy for the Air Force. This model can be used by the installation to provide pertinent information to the MAJCOM for strategic planning purposes. With the cost of imagery ranging in the hundreds of thousands of dollars, effective use of the limiting funding for GeoBase is essential. Only after an accurate assessment of change on an installation in comparison to its GeoBase imagery, can a MAJCOM determine the most appropriate course of action. Use of this model assists in this process.

Another recommendation is the automation of the data collection and model calculations. Automation can take the form of running ACES reports and using ACES to calculate the subtotal for each category. The change information obtained from ACES can be automatically inputted into an Excel program, which will include the predetermined category weights. The program can calculate the change value for the installation. Other automation processes include using GeoBase to identify the changes,

calculate the square footages, and run the equation. These automation steps serve to increase the efficiency of the process.

As satellite imagery provides higher resolution at much lower costs, different methods of acquiring the imagery should be considered. The value of this model may decrease if adequate satellite imagery is available at very little or no cost. Increasing technology is making satellite imagery more affordable than in the past. Current trends indicate that this trend will continue.

Conclusions

This proposed method of determining how much change has occurred on an installation is the recommended method for evaluating the refreshment requirements within a MAJCOM. The category weightings help to better represent the installation's priorities. This method is easy to use by the installations. The GeoBase personnel can use this model to help justify their requests for funding for new imagery.

With the model, MAJCOMs have a more objective method for evaluating requests for funding new imagery procurement. A clearer picture of each of their installation's changes allows for a more effective investment strategy by the MAJCOM. To standardize the information, a reporting process can be used. This reporting process, identified in Chapter Four, provides a systematic method for a MAJCOM to obtain each installation's information, requests and justifications. By using the four parts of the report, a MAJCOM can better determine a plan of action for imagery refreshment. Additionally, each installation will know where they stand in comparison to the other installations.

Each installation can compare their amount of change with other installations within their MAJCOM. Installations can use this model for their own planning purposes. Inputting future values for change will provide a future change value. This provides the installation a better idea of how the future changes will affect their installation in terms of their imagery. This information can be used in determining when to request refreshment. For example, if the installation knows that a significant amount of new construction or demolition is in the near future, then a request for new imagery funding may be delayed until the changes have been completed.

Limitations

Several factors were seen as limitations of this research. Four of the five limitations dealt with the development of the model. The last limitation involves the use of the model at the installation level.

The first limitation involved the level of information gathered by the researcher. An attempt was made to accurately gather all the changes to the installation that might be visible on the imagery and measure them using square footage. The researcher gathered all the data without visiting any of the installations. Even the determination of facility weighting values occurred electronically. Certain information was not available to the researcher due to time constraints. All facilities that were measured in a measurement other than area were omitted from the equation. When an installation gathers all the data, this type of information can be collected and used in the model.

The second limitation involves the environmental category. The six installations did not have any changes that fit in the environmental category. Therefore, this category

was not represented in the example. Information that would be placed in this category may have provided insight into the usefulness of this category and the impact of the low weighting.

The third limitation is the number of installations used in developing the model. Only six installations were represented, three from PACAF, two from AMC, and one from ACC. Conclusions made from a model using a small sample of the population must consider that the small sample may not accurately represent the entire population.

The fourth limitation involves the facilitation of category weightings. The facilitation process of obtaining weightings for attributes should be an interactive process between the expert (or group of experts) and the facilitator. While the research used accepted methods of obtaining the values, time restricted the interactive process. The expert was asked the questions and the answers were taken without any discussion between the facilitator and the expert. Using the rank-ordered method minimizes the affect of this limitation.

The last limitation involves the use of the model at the installation. The method of determining SF for changed features does not include any changes to the immediate vicinity surrounding the installation's boundaries. Facilities and other features that immediately surround an installation are extremely important to the installation, but are not typically tracked by the installation. Encroachment, airspace restrictions, and security are all considerations for the installation and imagery can be used to depict the existing conditions. The model does not incorporate these considerations.

Areas of Future Research

One area of future research involves using the process called change technology to verify the change value of the model. Change technology uses a computer to detect differences between two digital images. A prerequisite of using the different change technologies is two distinct images. The model was developed for determining when to acquire the second image. Future research could evaluate the changes using change technology on an installation after a second image has been acquired. A comparison of this model's change value and the value produced using change detection may prove insightful.

As mentioned in the limitations, the process to determine the weightings was not executed in person. Additionally, this research proposes that each MAJCOM develop their weights. Unfortunately due to time constraints, only one MAJCOM was used in the research. Follow-on research could entail face-to-face facilitation of values and the investigation of the different weights obtained from each of the MAJCOMs. A possibility exists that there would be little difference in the weightings values between the MAJCOMs, therefore indicating only one set of weights are required.

Appendix A: Installation List of Changes

This appendix includes an Excel matrix built for each installation identifying the changes in installation features since the last imagery was taken at the installation. Each list may not contain every change to the installation since the imagery was acquired due to different data collection methods used at the installation. Each change is classified into one of the twelve categories based on its category code. Changes which do not have a category code are classified into the environmental category. The attached matrices are provided in the following order:

- Kadena Air Base
- Anderson Air Force Base
- Eielson Air Force Base
- Grand Forks Air Force Base
- MacDill Air Force Base
- Barksdale Air Force Base

A short description of each of the eleven columns in the Excel matrix is provided below. The matrix is sorted by the Coding column to easily interpret the category SF totals. The Coding column is used to assign a number for each category.

INST_NAME_40	The name of the installation
FACT_ID_NR	A unique number assigned by the installation
CAT_NOMENCLATURE	A short description of the function of the facility
RP_AREA_AMT	Area value of the facility
AREA_UOM	The unit of measure for the facility's area
RP_OTH_AMT	Facility's value if another unit of measurement is used
OTH_UOM	Unit of measure for the facility if different measure is used
RP_CAT_PRES	Category Code assigned to the facility

TYPE	The type of change, i.e. demolition, new, addition
YR_COMP	Fiscal year the change was completed
IRR Category	Identifies which IRR Category for the facility
Coding	Number assigned to a category to sort the list by categories
Subtotal	Total square footage of each change within each category

KADENA AIR BASE CHANGED FEATURES

INSTL_NAME_40	FACT_ID_NR	CAT_NOMENCLATURE	RP_AREA_AMT	AREA_U0M	RP_OTH_AMT	OTH_U0M	RP_CAT_PRES	TYPE	YR_COMP	IRR Category	Coding	Subtotal
KADENA	1055	ACFT ARES SYS SPT	0		1	EA	116922	N/A	1998	Operations & Training	1	
KADENA	1064	ACFT ARES SYS SPT	0		1	EA	116922	N/A	1998	Operations & Training	1	
KADENA	1181	ACFT ARES SYS SPT	0		1	EA	116922	N/A	1998	Operations & Training	1	
KADENA	1280	DEFLECTOR,BLST			1	EA	116945	N/A	1999	Operations & Training	1	
KADENA	3400	TRML, AIR FRT	18,955	SF			141782	N/A	2000	Operations & Training	1	
KADENA	3401	TRML, AIR FRT	89	SF	0		141782	N/A	1998	Operations & Training	1	
KADENA	3507	SQ OPS	26,210	SF			141753	N/A	2000	Operations & Training	1	
KADENA	3628	COMM FCLTY	15,381	SF			131111	N/A	2000	Operations & Training	1	
KADENA	23628	COMM FCLTY	241	SF			131111	N/A	2000	Operations & Training	1	
KADENA	45019	TNG AID			1	EA	179371	N/A	2001	Operations & Training	1	
KADENA	45020	TECH TNG CLASSROOM	562	SF			171621	N/A	2001	Operations & Training	1	
KADENA	45105	TECH TNG CLASSROOM	2,700	SF			171621	N/A	2000	Operations & Training	1	
KADENA	45106	TECH TNG CLASSROOM	2,700	SF			171621	N/A	2002	Operations & Training	1	
KADENA	73335	ILS GLIDE SLOPE	86	SF	1	EA	134351	N/A	1998	Operations & Training	1	66,924
KADENA	851	BE STOR SHED	3,096	SF			219947	N/A	2000	Maintenance & Production	3	
KADENA	3422	SHP A/SE STOR FCLT	3,354	SF			218712	N/A	2001	Maintenance & Production	3	
KADENA	3466	SHP A/SE STOR FCLT	4,558	SF			218712	N/A	2002	Maintenance & Production	3	
KADENA	3470	VEH OPS PKNG SHED	4,836	SF			214428	N/A	2000	Maintenance & Production	3	
KADENA	3471	VEH OPS PKNG SHED	4,836	SF			214428	N/A	2000	Maintenance & Production	3	
KADENA	3551	ACFT COR CON	2,721	SF	0		211159	N/A	1998	Maintenance & Production	3	
KADENA	3639	SHP ACFT GEN PURP	2,244	SF			211152	N/A	2000	Maintenance & Production	3	
KADENA	45503	BE STOR SHED	7,440	SF			219947	N/A	2001	Maintenance & Production	3	
KADENA	45811	SHP CONVL MUN	18,116	SF			216642	N/A	1999	Maintenance & Production	3	
KADENA	47801	SHP, SRVLL INSP	15,155	SF			215582	N/A	1998	Maintenance & Production	3	66,356
KADENA	171	HSG SUP&STOR FCLTY	1,203	SF			442769	N/A	1998	Supply	5	2,883
KADENA	616	HSG SUP&STOR FCLTY	1,163	SF			442769	N/A	1998	Supply	5	
KADENA	760	HSG SUP&STOR FCLTY	386	SF			442769	N/A	1998	Supply	5	
KADENA	770	HSG SUP&STOR FCLTY	386	SF			442769	N/A	1998	Supply	5	
KADENA	1218	STOR, JET FL	0		80,000	BL	411135	N/A	1998	Supply	5	
KADENA	1219	STOR, JET FL	0		80,000	BL	411135	N/A	1998	Supply	5	
KADENA	3157	SHED SUP&EQUIP BSE	334	SF			442628	N/A	2000	Supply	5	
KADENA	3465	WHSE SUP&EQUIP BSE	438	SF			442758	N/A	2001	Supply	5	
KADENA	47099	ANCLY EXPLO FCLTY			1	EA	422275	N/A	1998	Supply	5	
KADENA	48953	STOR, IGLOO	1,991	SF	1	EA	422264	N/A	2001	Supply	5	
KADENA	48954	STOR, IGLOO	1,991	SF	1	EA	422264	N/A	2001	Supply	5	

KADENA	48955	STOR, IGLOO	1,991 SF	1 EA	422264	N/A	2001	Supply	5	
KADENA	48956	STOR, IGLOO	1,991 SF	1 EA	422264	N/A	2001	Supply	5	
KADENA	48957	STOR, IGLOO	1,991 SF	1 EA	422264	N/A	2001	Supply	5	
KADENA	49611	STOR MODULE BARCAD	52,380 SF		422271	N/A	1999	Supply	5	66,245
KADENA	626	COMPOSITE MED	231,766 SF	1 BD	510001	N/A	1999	Medical	6	231,766
KADENA	235	BSE ENGR ADMIN	1,375 SF	0	610127	N/A	1998	Administration	7	
KADENA	3151	TRAFFIC MGT FCLTY	10,791 SF		610142	N/A	2001	Administration	7	
KADENA	47899	MUN MAINT ADMIN	2,263 SF		610144	N/A	1998	Administration	7	14,429
KADENA	28	O/D RECTN PAVILION	1,132 SF	1 EA	750371	N/A	1999	Community Support	8	
KADENA	59	EDUCATION CEN	46,532 SF		730441	N/A	2002	Community Support	8	
KADENA	156	SAN LATRINE	544 SF		723392	N/A	1999	Community Support	8	
KADENA	178	DH, AMN(DET)	17,900 SF	1,000 PN	722351	N/A	2001	Community Support	8	
KADENA	334	CHILD CARE CEN	23,594 SF		740884	N/A	1998	Community Support	8	
KADENA	772	DH, AMN(DET)	15,521 SF	1,000 PN	722351	N/A	1999	Community Support	8	
KADENA	3629	RESTAURANT, BASE	8,400 SF		740735	N/A	2000	Community Support	8	
KADENA	4081	CHILD CARE CEN	23,594 SF		740884	N/A	1999	Community Support	8	
KADENA	9497	SCH DEPN DET SPT	32,927 SF		730783	N/A	2002	Community Support	8	
KADENA	20334	MWR SUP/NAF C-STOR	43 SF		740672	N/A	1998	Community Support	8	
KADENA	20335	MWR SUP/NAF C-STOR	43 SF		740672	N/A	1998	Community Support	8	
KADENA	24081	MWR SUP/NAF C-STOR	43 SF		740672	N/A	1999	Community Support	8	
KADENA	24082	MWR SUP/NAF C-STOR	43 SF		740672	N/A	1999	Community Support	8	
KADENA	46015	SP ENTRY CON BLDG	96 SF	0	730837	N/A	1999	Community Support	8	
KADENA	48090	MONUMENTS/MEMORL		3 EA	760512	N/A	1999	Community Support	8	
KADENA	70138	O/D RECTN PAVILION	560 SF	1 EA	750371	N/A	2001	Community Support	8	
KADENA	70613	O/D RECTN PAVILION	560 SF	1 EA	750371	N/A	2002	Community Support	8	
KADENA	71849	MISC O/RECTN FCLTY		1 EA	750581	N/A	1999	Community Support	8	
KADENA	74081	MISC O/RECTN FCLTY		2 EA	750581	N/A	1999	Community Support	8	171,532
KADENA	176	DORM AM PP/PCS-STD	66,736 SF	194 PN	721312	N/A	2001	Dormitories	10	
KADENA	177	DORM AM PP/PCS-STD	67,628 SF	194 PN	721312	N/A	2001	Dormitories	10	
KADENA	629	DORM AM PP/PCS-STD	66,661 SF	194 PN	721312	N/A	1999	Dormitories	10	
KADENA	630	DORM AM PP/PCS-STD	66,661 SF	194 PN	721312	N/A	1999	Dormitories	10	267,686
KADENA	180	WTR FR PMP STN	710 SF	1,821 GM	843316	N/A	1998	UGI	11	
KADENA	342	BLDG WTR SUP	299 SF		841169	N/A	1998	UGI	11	
KADENA	2834	SAN SEWAGE PMP STN	220 SF		832267	N/A	1999	UGI	11	
KADENA	3335	ELEC PWR STN BLDG	216 SF		811149	N/A	1998	UGI	11	
KADENA	3397	ELEC PWR STN BLDG	277 SF		811149	N/A	2000	UGI	11	
KADENA	3506	ELEC PWR STN BLDG	204 SF		811149	N/A	2000	UGI	11	
KADENA	4067	BLDG WTR SUP	299 SF		841169	N/A	1998	UGI	11	
KADENA	5011	SAN SEWAGE PMP STN	232 SF		832267	N/A	1999	UGI	11	
KADENA	9498	ELEC PWR STN BLDG	193 SF		811149	N/A	2002	UGI	11	
KADENA	46014	ELEC PWR STN BLDG	233 SF		811149	N/A	1999	UGI	11	
KADENA	49050	FR PROTEC WTR STOR	0	5 KG	843319	N/A	1998	UGI	11	2,883

ANDERSEN AIR FORCE BASE CHANGED FEATURES

INSTL_ NAME_40	FACT_ ID_NR	CAT_ NOMENCLATURE	RP_AREA _AMT	AREA _U0M	RP_OTH _AMT	OTH _U0M	RP_CAT _PRES	TYPE	YR_ COMP	IRR Category	Coding	Subtotal
ANDERSEN	26207	POL Fuel Tanks			100000	BP	411135	N	2001	Supply	5	
ANDERSEN	26208	POL Fuel Tanks			100000	BP	411136	N	2000	Supply	5	200000

EIELSON AIR FORCE BASE CHANGED FEATURES

INSTL_ NAME_40	FACT_ ID_NR	CAT_ NOMENCLATURE	RP_AREA _AMT	AREA _U0M	RP_OTH _AMT	OTH _U0M	RP_CAT _PRES	TYPE	YR_ COMP	IRR Category	Coding	Subtotal
EIELSON	1110	OPG STOR,DIESEL			250	GA	124134	A	2001	Operations & Training	1	
EIELSON	1110	ILS GLIDE SLOPE	240	SF	1	EA	134351	A	2001	Operations & Training	1	
EIELSON	1149	AIRFIELD LIGHTING VAULT	1200	SF			136668	A	2001	Operations & Training	1	
EIELSON	1186	RAD RELAY FCLTY	210	SF			131118	A	2001	Operations & Training	1	
EIELSON	1211	AVFUEL DISPEN			3600	GM	121115	A	2001	Operations & Training	1	
EIELSON	1211	HYDR FL SYS			3600	GM	121122	A	2001	Operations & Training	1	
EIELSON	1211	HYDR FL,BLDG	6501	SF			121124	A	2001	Operations & Training	1	
EIELSON	1211	HYDR FL,BLDG	4471	SF			121124	A	2001	Operations & Training	1	
EIELSON	1212	AVFUEL DISPEN			3600	GM	121115	A	2001	Operations & Training	1	
EIELSON	1212	LF FIL STD, TRK			6	OL	126925	A	2001	Operations & Training	1	
EIELSON	3241	OPG STOR,JET FL			420000	GA	124135	A	2001	Operations & Training	1	
EIELSON	3244	OPG STOR,JET FL			420000	GA	124135	A	2001	Operations & Training	1	
EIELSON	3246	HYDR FL,BLDG	80	SF			121124	A	2001	Operations & Training	1	
EIELSON	6402	RAD RELAY FCLTY	400	SF			131118	A	2001	Operations & Training	1	
EIELSON	9050	TEL DUCT FCLTY			139000	LF	135583	A	2001	Operations & Training	1	13102
EIELSON	2211	VEH OPS HEAT PKNG	783	SF			214426	A	2001	Maintenance and Production	3	
EIELSON	4336	BE STOR CV FCLTY	960	SF			219946	A	2001	Maintenance and Production	3	
EIELSON	4365	SHP,WPN & RLSE SYS	8,409.00	SF	0		215552	D	2001	Maintenance and Production	3	
EIELSON	6379	SHP CONVL MUN	770	SF	0		216642	D	2001	Maintenance and Production	3	10922
EIELSON	1211	WHSE SUP&EQUIP BSE	2030	SF			442758	A	2001	Supply	5	
EIELSON	3434	COLD STOR BSE	13,482.00	SF	64,320.00	CF	432283	D	2001	Supply	5	
EIELSON	4113	HSG SUP-STOR FCLTY	4,474.00	SF	0		442769	D	2002	Supply	5	19,986.00
EIELSON	1221	WPN SYS/M MGT FCLT	9,931.00	SF	0		610129	D	2001	Admin	7	
EIELSON	1230	WPN SYS/M MGT FCLT	4,923.00	SF	0		610129	D	2001	Admin	7	
EIELSON	1353	WPN SYS/M MGT FCLT	26625	SF			610129	A	2001	Admin	7	
EIELSON	4112	WPN SYS/M MGT FCLT	8,732.00	SF	0		610129	D	2002	Admin	7	50,211.00
EIELSON	5127	TLF (NAF)	12,757.00	SF	8	FA	740457	D	2001	Community Support	8	
EIELSON	6000	FAM CAMPS	740520	SF	41	VP	750611	A	2001	Community Support	8	
EIELSON	6005	FAMCAMP SPT FAC	1134	SF			750612	A	2001	Community Support	8	
EIELSON	6388	MISC O/RECTN FCLTY			1	EA	750581	A	2001	Community Support	8	754,411
EIELSON	5130	FAM HSG APPR 50-69	12,757.00	SF	8	FA	711143	D	2001	Housing	9	
EIELSON	5132	FAM HSG APPR 50-69	12,757.00	SF	8	FA	711143	D	2001	Housing	9	
EIELSON	5150	FAM HSG APPR 50-69	12,757.00	SF	8	FA	711143	D	2001	Housing	9	
EIELSON	5189	FAM HSG APPR 50-69	12,757.00	SF	8	FA	711143	D	2001	Housing	9	
EIELSON	5228	FAM HSG APPR 50-69	8056	SF	4	FA	711143	A	2001	Housing	9	
EIELSON	5228	FAM HSG ATCH GARGE	1348	SF	8	VE	711311	A	2001	Housing	9	

EIELSON	5229	FAM HSG APPR 50-69	8056	SF	4	FA	711143	A	2001	Housing	9	
EIELSON	5229	FAM HSG ATCH GARGE	1348	SF	8	VE	711311	A	2001	Housing	9	
EIELSON	5230	FAM HSG APPR 50-69	12084	SF	6	FA	711143	A	2001	Housing	9	
EIELSON	5230	FAM HSG ATCH GARGE	2022	SF	12	VE	711311	A	2001	Housing	9	
EIELSON	5231	FAM HSG APPR 50-69	12084	SF	6	FA	711143	A	2001	Housing	9	
EIELSON	5231	FAM HSG ATCH GARGE	2022	SF	12	VE	711311	A	2001	Housing	9	
EIELSON	5232	FAM HSG APPR 50-69	8056	SF	4	FA	711143	A	2001	Housing	9	
EIELSON	5232	FAM HSG ATCH GARGE	1348	SF	8	VE	711311	A	2001	Housing	9	
EIELSON	5233	FAM HSG APPR 50-69	8056	SF	4	FA	711143	A	2001	Housing	9	
EIELSON	5233	FAM HSG ATCH GARGE	1348	SF	8	VE	711311	A	2001	Housing	9	
EIELSON	5234	FAM HSG APPR 50-69	12084	SF	6	FA	711143	A	2001	Housing	9	
EIELSON	5234	FAM HSG ATCH GARGE	2022	SF	12	VE	711311	A	2001	Housing	9	
EIELSON	5235	FAM HSG APPR 50-69	12084	SF	6	FA	711143	A	2001	Housing	9	
EIELSON	5235	FAM HSG ATCH GARGE	2022	SF	12	VE	711311	A	2001	Housing	9	
EIELSON	5236	FAM HSG APPR 50-69	12084	SF	6	FA	711143	A	2001	Housing	9	
EIELSON	5236	FAM HSG ATCH GARGE	2022	SF	12	VE	711311	A	2001	Housing	9	159174
EIELSON	2200	DORM AM PP/PCS-STD	12995	SF	120	PN	721312	A	2002	Dormitories	10	12995
EIELSON	1110	ELEC E/PWR GEN PLT			60	KW	811147	A	2001	UGI	11	
EIELSON	1110	AUTO FR DTECTN SYS	240	SF	1	EA	880221	A	2001	UGI	11	
EIELSON	1211	ELEC E/PWR GEN PLT			500	KW	811147	A	2001	UGI	11	
EIELSON	1211	AUTO FR DTECTN SYS	6501	SF	1	EA	880221	A	2001	UGI	11	
EIELSON	1211	MAN FR ALRM/I SYS			1	EA	880222	A	2001	UGI	11	
EIELSON	1211	CATHOD PROTEC SYS			1	EA	890269	A	2001	UGI	11	
EIELSON	1353	CLSD HD A/SPRINK	26625	SF	306	HD	880211	A	2001	UGI	11	
EIELSON	1353	AUTO FR DTECTN SYS	26625	SF	1	EA	880221	A	2001	UGI	11	
EIELSON	1353	MAN FR ALRM/I SYS			1	EA	880222	A	2001	UGI	11	
EIELSON	3008	EMCS FIELD EQUIP			1	EA	890272	A	2002	UGI	11	
EIELSON	3009	EMCS DATA LINKS			300	LF	890273	A	2002	UGI	11	
EIELSON	4336	MAN FR ALRM/I SYS			1	EA	880222	A	2001	UGI	11	
EIELSON	4337	GRBG CNT WASH RACK	400	SF	1	EA	833358	A	2001	UGI	11	
EIELSON	4337	MAN FR ALRM/I SYS			1	EA	880222	A	2001	UGI	11	
EIELSON	5228	AUTO FR DTECTN SYS	8056	SF	1	EA	880221	A	2001	UGI	11	
EIELSON	5229	AUTO FR DTECTN SYS	8056	SF	1	EA	880221	A	2001	UGI	11	
EIELSON	5230	AUTO FR DTECTN SYS	12084	SF	1	EA	880221	A	2001	UGI	11	
EIELSON	5231	AUTO FR DTECTN SYS	12084	SF	1	EA	880221	A	2001	UGI	11	
EIELSON	5232	AUTO FR DTECTN SYS	8056	SF	1	EA	880221	A	2001	UGI	11	
EIELSON	5233	AUTO FR DTECTN SYS	8056	SF	1	EA	880221	A	2001	UGI	11	
EIELSON	5234	AUTO FR DTECTN SYS	12084	SF	1	EA	880221	A	2001	UGI	11	
EIELSON	5235	AUTO FR DTECTN SYS	12084	SF	1	EA	880221	A	2001	UGI	11	
EIELSON	5236	AUTO FR DTECTN SYS	12084	SF	1	EA	880221	A	2001	UGI	11	
EIELSON	6005	HTG FL OIL STOR			1000	GA	821112	A	2001	UGI	11	
EIELSON	6005	MAN FR ALRM/I SYS			1	EA	880222	A	2001	UGI	11	
EIELSON	6006	WTR WELL			5	KG	841166	A	2001	UGI	11	
EIELSON	6006	BLDG WTR SUP	48	SF			841169	A	2001	UGI	11	
EIELSON	6221	SPT STRU			1	EA	890161	A	2001	UGI	11	
EIELSON	6402	AUTO FR DTECTN SYS	400	SF	1	EA	880221	A	2001	UGI	11	
EIELSON	76000	ELEC SUBSTATION			50	KV	813231	A	2001	UGI	11	
EIELSON	76005	SEC DISTR LNE UG			2450	LF	812226	A	2001	UGI	11	
EIELSON	76005	SEWAGE TRMT & DSPL			10	KG	831165	A	2001	UGI	11	
EIELSON	86005	WTR DISTR MAINS			1738	LF	842245	A	2001	UGI	11	153483

GRAND FORKS AIR FORCE BASE CHANGED FEATURES

INSTL_ NAME_40	FACT_ ID_NR	CAT_ NOMENCLATURE	RP_ARE A_AMT	AREA _U0M	RP_OTH _AMT	OTH _U0M	RP_CAT _PRES	TYPE	IRR Category	Coding	Subtotal
GRAND FORKS	312	TECH TNG LAB/SHP	1777	SF	0		171623	D	Operations & Training	1	
GRAND FORKS	519	HELI,RESC/RECOVY	21241	SF	0		141185	D	Operations & Training	1	
GRAND FORKS	533	AUDIO-VISUAL FCLTY	5710	SF	0		141383	D	Operations & Training	1	
GRAND FORKS	541	KC-135 SQ OPS/AMU	25160	SF	0		141753	N	Operations & Training	1	
GRAND FORKS	542	KC-135 SQ OPS/AMU	24027	SF	0		141753	N	Operations & Training	1	
GRAND FORKS	555	VEH FL STN	30	SF	2	OL	123335	D	Operations & Training	1	
GRAND FORKS	612	HYDR FL, BLDG	2475	SF	0		121124	D	Operations & Training	1	
GRAND FORKS	627	ASR	2400	SF	1	EA	134376	D	Operations & Training	1	
GRAND FORKS	631	KC-135 SQ OPS/AMU	22508	SF	0		141753	N	Operations & Training	1	
GRAND FORKS	821	ASR	646	SF	0		134376	N	Operations & Training	1	105,973.87
GRAND FORKS	524	BE STOR CV FCTLY	240	SF	0		219946	D	Maintenance and Production	3	
GRAND FORKS	525	VEH OPS HEAT PKNG	9460	SF	0		214426	D	Maintenance and Production	3	
GRAND FORKS	622	ACFT COR CONTROL	3494	SF	0		211159	A	Maintenance and Production	3	13,194.25
GRAND FORKS	235	HSG SUP-STOR FCLTY	576	SF	0		442769	D	Supply	5	
GRAND FORKS	317	HAZARD STOR, BSE	128	SF	0		442257	D	Supply	5	
GRAND FORKS	324	HSG SUP-STOR FCLTY	2064	SF	0		442769	D	Supply	5	
GRAND FORKS	419	HAZARD STOR, BSE	960	SF	0		442257	D	Supply	5	
GRAND FORKS	420	HAZARD STOR, BSE	1326	SF	0		442257	D	Supply	5	
GRAND FORKS	421	OPEN STOR,BSE SUP	21665	SY	0		452252	D	Supply	5	
GRAND FORKS	426	WHSE SUP&EQUIP BSE	4100	SF	0		442758	D	Supply	5	
GRAND FORKS	464	SHED SUP&EQUIP BSE	80	SF	0		442628	D	Supply	5	30,899.00
GRAND FORKS	109	MEDICAL CLINIC	15287	SF	0		510001	A	Medical	6	15286.844
GRAND FORKS	216	HQ GROUP	5356	SF	0		610243	D	Admin	7	
GRAND FORKS	226	HQ GROUP	2048	SF	0		610243	D	Admin	7	
GRAND FORKS	429	ADMIN OFC,NON-AF	1680	SF	0		610811	D	Admin	7	9,084.00
GRAND FORKS	143	NEW TLF, 10 UNIT	13032	SF	0		740457	N	Community Support	8	
GRAND FORKS	200	EXCH, SVC STN	3380	SF	0		740383	D	Community Support	8	
GRAND FORKS	211	THRIFT SHP	9600	SF	0		740255	D	Community Support	8	
GRAND FORKS	223	DORM, VAQ	18000	SF	68	PN	721315	D	Community Support	8	
GRAND FORKS	225	DORM, VAQ	18000	SF	68	PN	721315	D	Community Support	8	
GRAND FORKS	229	TLF (NAF)	18000	SF	68	FA	740457	D	Community Support	8	
GRAND FORKS	230	POST OFFICE CEN	10573	SF	0		730443	D	Community Support	8	
GRAND FORKS	240	EXCH, AMUSE CEN	650	SF	0		740379	D	Community Support	8	
GRAND FORKS	246	TRN LODGE SPT BLDG	356	SF	0		740459	D	Community Support	8	
GRAND FORKS	247	TLF (NAF)	4154	SF	10	FA	740457	D	Community Support	8	
GRAND FORKS	248	TLF (NAF)	4154	SF	10	FA	740457	D	Community Support	8	
GRAND FORKS	251	TRN LODGE SPT BLDG	250	SF	0		740459	D	Community Support	8	
GRAND FORKS	308	FITNESS CENTER	47839	SF	0		740674	A	Community Support	8	
GRAND FORKS	315	AIREY DINING HALL	27432	SF	0		740612	N	Community Support	8	
GRAND FORKS	319	BARNES HALL	21089	SF	0		740612	N	Community Support	8	
GRAND FORKS	338	PAVILION	2835	SF	0		750371	N	Community Support	8	
GRAND FORKS	624	RIDING STABLES	4750	SF	1	EA	750583	D	Community Support	8	
GRAND FORKS	838	MASTER SRVLL & CON	198	SF	1	EA	730838	D	Community Support	8	
GRAND FORKS	1005	PAVILION SHELTERS	2245	SF	0		750371	N	Community Support	8	

GRAND FORKS	2313	BUS, SHLTR	50	SF	0		730275	D	Community Support	8	
GRAND FORKS		SCHOOL STORAGE SHED	533	SF	0		730842	N	Community Support	8	
GRAND FORKS		BASE BALL DUGOUT	83	SF	0		750179	N	Community Support	8	
GRAND FORKS		BASE BALL DUGOUT	124	SF	0		750179	N	Community Support	8	207,327.59
GRAND FORKS	1108	FAM HSG, CAPEHART	8782	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1112	FAM HSG, CAPEHART	8782	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1115	FAM HSG, CAPEHART	9082	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1116	FAM HSG, CAPEHART	8782	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1117	FAM HSG, CAPEHART	10444	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1118	FAM HSG, CAPEHART	10444	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1119	FAM HSG, CAPEHART	10444	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1120	FAM HSG, CAPEHART	10444	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1121	FAM HSG, CAPEHART	8782	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1122	FAM HSG, CAPEHART	9082	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1123	FAM HSG, CAPEHART	8948	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1124	FAM HSG, CAPEHART	8948	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1125	FAM HSG, CAPEHART	9082	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1126	FAM HSG, CAPEHART	8782	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1127	FAM HSG, CAPEHART	8948	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1128	FAM HSG, CAPEHART	8948	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1129	FAM HSG, CAPEHART	8782	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1130	FAM HSG, CAPEHART	9082	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1131	FAM HSG, CAPEHART	8948	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1132	FAM HSG, CAPEHART	8782	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1133	FAM HSG, CAPEHART	8782	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1134	FAM HSG, CAPEHART	8948	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1135	FAM HSG, CAPEHART	8782	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1136	FAM HSG, CAPEHART	9082	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1137	FAM HSG, CAPEHART	8948	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1138	FAM HSG, CAPEHART	8782	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1139	FAM HSG, CAPEHART	8782	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1140	FAM HSG, CAPEHART	9082	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1141	FAM HSG, CAPEHART	8948	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1142	FAM HSG, CAPEHART	8782	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1143	FAM HSG, CAPEHART	8782	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1144	FAM HSG, CAPEHART	9082	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1145	FAM HSG, CAPEHART	9082	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1146	FAM HSG, CAPEHART	8782	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1147	FAM HSG, CAPEHART	9082	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1149	FAM HSG, CAPEHART	8782	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1201	FAM HSG, CAPEHART	3352	SF	2	FA	711111	D	Housing	9	
GRAND FORKS	1225	FAM HSG, CAPEHART	6409	SF	4	FA	711111	D	Housing	9	
GRAND FORKS	1295	FAM HSG, CAPEHART	3352	SF	2	FA	711111	D	Housing	9	
GRAND FORKS	1431	GARGE FAM HSG DET	936	SF	3	VE	714431	D	Housing	9	
GRAND FORKS	1502	FAM HSG, CAPEHART	9082	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1504	FAM HSG, CAPEHART	8782	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1505	FAM HSG, CAPEHART	8948	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1506	FAM HSG, CAPEHART	8782	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1508	FAM HSG, CAPEHART	9082	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1510	FAM HSG, CAPEHART	8782	SF	6	FA	711111	D	Housing	9	
GRAND FORKS	1602	FAM HSG, CAPEHART	8782	SF	6	FA	711111	D	Housing	9	

MACDILL AIR FORCE BASE CHANGED FEATURES

INSTL_ NAME_40	FACT_ ID_NR	CAT_ NOMENCLATURE	RP_AREA _AMT	AREA _U0M	RP_OTH _AMT	OTH _U0M	RP_CAT _PRES	TYPE	YR_ COMP	IRR Category	Coding	Subtotal
MACDILL	172	DISASTER PREP	1403.00	SF	0.00		610913	D	2001	Operations & Training	1	
MACDILL	295	KC-135 FLT SIM	13498.00	SF	0.00		171212	D	2002	Operations & Training	1	
MACDILL	517	ACFT WASH RACK	100.00	SY	0.00		116672	N	2000	Operations & Training	1	
MACDILL	543	OPS, SP	3069.00	SF	0.00		141454	N	1995	Operations & Training	1	
MACDILL	556	Ant Spt STR	0.00	XX	1.00	EA	132134	N	2000	Operations & Training	1	
MACDILL	557	Veh Fl Stn	658.00	SF	0.00		123335	N	1999	Operations & Training	1	
MACDILL	1058	SATCOM Facility	5382.00	SF	0.00		131111	N	2002	Operations & Training	1	
MACDILL	1059	PETROL OPS BLDG	96.00	SF	0.00		121111	D	2001	Operations & Training	1	
MACDILL	1060	SAT COMM GND TRML	400.00	SF	1.00	EA	131132	D	2001	Operations & Training	1	
MACDILL	1108	TWR, CON	3152.00	SF	1.00	EA	149962	D	2001	Operations & Training	1	
MACDILL	1146	TWR, NAVAID	0.00	XX	1.00	EA	134473	D	2001	Operations & Training	1	
MACDILL	1155	OPG STOR, MOGAS	0.00	XX	20000.00	GA	124137	D	2001	Operations & Training	1	
MACDILL	1188	FIREMAN TNG FCLTY	0.00	XX	1.00	EA	179511	D	2001	Operations & Training	1	
MACDILL	3025	PHOTO LAB, BSE	120.00	SF	0.00		141743	D	2000	Operations & Training	1	
MACDILL	3040	COMM FCLTY	120.00	SF	0.00		131111	D	2000	Operations & Training	1	
MACDILL	3041	COMM FCLTY	120.00	SF	0.00		131111	D	2000	Operations & Training	1	
MACDILL	3048	COMM FCLTY	120.00	SF	0.00		131111	D	2000	Operations & Training	1	
MACDILL	3049	COMM FCLTY	120.00	SF	0.00		131111	D	2000	Operations & Training	1	
MACDILL	3053	DISASTER PREP	120.00	SF	0.00		610913	D	2000	Operations & Training	1	
MACDILL	3060	COMM, RCVR	120.00	SF	0.00		131115	D	2000	Operations & Training	1	
MACDILL	3065	DISASTER PREP	120.00	SF	0.00		610913	D	2000	Operations & Training	1	
MACDILL	3159	PETROL OPS BLDG	120.00	SF	0.00		121111	D	2000	Operations & Training	1	
MACDILL	3161	GCA FIXED	120.00	SF	1.00	EA	134336	D	2000	Operations & Training	1	
MACDILL	3162	PETROL OPS BLDG	120.00	SF	0.00		121111	D	2000	Operations & Training	1	
MACDILL	3163	PETROL OPS BLDG	120.00	SF	0.00		121111	D	2000	Operations & Training	1	
MACDILL	3169	RAD, MARS	120.00	SF	0.00		131114	D	2000	Operations & Training	1	
MACDILL	3262	COMM FCLTY	120.00	SF	0.00		131111	D	2000	Operations & Training	1	
MACDILL	3263	COMM FCLTY	120.00	SF	0.00		131111	D	2000	Operations & Training	1	
MACDILL	3299	FLD TNG FCLTY	120.00	SF	0.00		171618	D	2000	Operations & Training	1	
MACDILL	3699	EOD	120.00	SF	0.00		141165	D	2000	Operations & Training	1	
MACDILL	3700	EOD	120.00	SF	0.00		141165	D	2000	Operations & Training	1	
MACDILL	3710	PHYSL TNG	120.00	SF	0.00		171214	D	2000	Operations & Training	1	
MACDILL	3723	RES FORCES C-E TNG	300.00	SF	0.00		171447	D	2000	Operations & Training	1	
MACDILL	3805	COMM, TMTR RCVR	120.00	SF	0.00		131116	D	2000	Operations & Training	1	
MACDILL	3881	RG CON HSE	120.00	SF	0.00		171471	D	2000	Operations & Training	1	
MACDILL	3882	RG CON HSE	120.00	SF	0.00		171471	D	2000	Operations & Training	1	
MACDILL	13031	RUNWAY	96589.00	SY	0.00		111111	D	2001	Operations & Training	1	127287

MACDILL	11	BE STOR CV FCTLY	17484.00 SF	0.00	219946	D	2001	Maintenance & Production	3
MACDILL	12	BE MAINT SHOP	9918.00 SF	0.00	219944	D	2001	Maintenance & Production	3
MACDILL	12	BE MAINT SHOP	5944.00 SF	0.00	132135	D	2001	Maintenance & Production	3
MACDILL	29	BE MAINT SHOP	9115.00 SF	0.00	179512	D	2001	Maintenance & Production	3
MACDILL	31	BE MAINT SHOP	460.00 SF	0.00	610913	D	2001	Maintenance & Production	3
MACDILL	32	BE MAINT SHOP	5199.00 SF	0.00	610913	D	2001	Maintenance & Production	3
MACDILL	32	BE MAINT SHOP	3907.00 SF	0.00	62132	D	2001	Maintenance & Production	3
MACDILL	32	BE STOR CV FCTLY	1292.00 SF	0.00	7592	D	2001	Maintenance & Production	3
MACDILL	33	BE MAINT SHOP	3261.00 SF	0.00	141455	D	2001	Maintenance & Production	3
MACDILL	33	BE PAV GRND FCLTY	1246.00 SF	0.00	127837	D	2001	Maintenance & Production	3
MACDILL	33	BE MAINT SHOP	2015.00 SF	0.00	127326	D	2001	Maintenance & Production	3
MACDILL	35	BE MAINT SHOP	594.00 SF	0.00	126814	D	2001	Maintenance & Production	3
MACDILL	44	NOAA Facility	4000.00 SF		121111	D	2000	Maintenance & Production	3
MACDILL	119	VEH OPS PKNG SHED	924.00 SF	0.00	131132	D	2001	Maintenance & Production	3
MACDILL	227	BE STOR CV FCTLY	9215.00 SF	0.00	132135	D	2001	Maintenance & Production	3
MACDILL	248	BE STOR CV FCTLY	600.00 SF	0.00	179512	D	2001	Maintenance & Production	3
MACDILL	500	VEH MAIN SHP	34644.00 SF	0.00	610913	D	2001	Maintenance & Production	3
MACDILL	510	VEH SVC RACK	1056.00 SF	1.00 EA	610913	D	2001	Maintenance & Production	3
MACDILL	740	BE MAINT SHOP	2089.00 SF	0.00	62132	D	2001	Maintenance & Production	3
MACDILL	1064	BE MAINT SHOP	1848.00 SF	0.00	7592	D	2001	Maintenance & Production	3
MACDILL	1074	BE STOR SHED	1584.00 SF	0.00	141455	D	2001	Maintenance & Production	3
MACDILL	1076	BE STOR SHED	910.00 SF	0.00	127837	D	2001	Maintenance & Production	3
MACDILL	1185	BE STOR CV FCTLY	432.00 SF	0.00	127326	D	2001	Maintenance & Production	3
MACDILL	1361	SHP,WPN & RLSE SYS	140.00 SF	0.00	126814	D	2000	Maintenance & Production	3
MACDILL	1847	VEH SVC RACK	1500.00 SF	1.00 EA	121111	D	2001	Maintenance & Production	3
MACDILL	3004	SHP ACFT GEN PURP	120.00 SF	0.00	131132	D	2000	Maintenance & Production	3
MACDILL	3008	BE STOR CV FCTLY	240.00 SF	0.00	149962	D	2000	Maintenance & Production	3
MACDILL	3026	BE STOR CV FCTLY	120.00 SF	0.00	134473	D	2000	Maintenance & Production	3
MACDILL	3029	BE MAINT SHOP	120.00 SF	0.00	124137	D	2000	Maintenance & Production	3
MACDILL	3031	BE MAINT SHOP	120.00 SF	0.00	179511	D	2000	Maintenance & Production	3
MACDILL	3032	BE MAINT SHOP	120.00 SF	0.00	141743	D	2000	Maintenance & Production	3
MACDILL	3033	BE MAINT SHOP	120.00 SF	0.00	131111	D	2000	Maintenance & Production	3
MACDILL	3037	BE STOR CV FCTLY	120.00 SF	0.00	131111	D	2000	Maintenance & Production	3
MACDILL	3042	LAB, PME	120.00 SF	0.00	131111	D	2000	Maintenance & Production	3
MACDILL	3050	BE MAINT SHOP	120.00 SF	0.00	131111	D	2000	Maintenance & Production	3
MACDILL	3057	AFCS MAINT FCLTY	120.00 SF	0.00	610913	D	2000	Maintenance & Production	3
MACDILL	3058	BE STOR CV FCTLY	120.00 SF	0.00	131115	D	2000	Maintenance & Production	3
MACDILL	3062	BE STOR CV FCTLY	120.00 SF	0.00	610913	D	2000	Maintenance & Production	3
MACDILL	3063	BE STOR CV FCTLY	120.00 SF	0.00	121111	D	2000	Maintenance & Production	3
MACDILL	3078	SHP SURV EQUIP	192.00 SF	0.00	134336	D	2000	Maintenance & Production	3
MACDILL	3079	SHP SURV EQUIP	192.00 SF	0.00	121111	D	2000	Maintenance & Production	3
MACDILL	3111	BE STOR CV FCTLY	120.00 SF	0.00	121111	D	2000	Maintenance & Production	3
MACDILL	3150	BE MAINT SHOP	120.00 SF	0.00	131114	D	2000	Maintenance & Production	3
MACDILL	3154	SHP NAVAID	120.00 SF	0.00	131111	D	2000	Maintenance & Production	3

MACDILL	3247	BE MAINT SHOP	120.00 SF	0.00	131111	D	2000	Maintenance & Production	3	
MACDILL	3293	BE MAINT SHOP	120.00 SF	0.00	171618	D	2000	Maintenance & Production	3	
MACDILL	3500	VEH MAIN SHP	120.00 SF	0.00	141165	D	2000	Maintenance & Production	3	
MACDILL	3551	SHP A/SE STOR FCLT	120.00 SF	0.00	141165	D	2000	Maintenance & Production	3	
MACDILL	3552	SHP A/SE STOR FCLT	120.00 SF	0.00	171214	D	2000	Maintenance & Production	3	
MACDILL	3740	BE MAINT SHOP	120.00 SF	0.00	171447	D	2000	Maintenance & Production	3	
MACDILL	3741	BE MAINT SHOP	120.00 SF	0.00	131116	D	2000	Maintenance & Production	3	
MACDILL	3837	SHP CONVL MUN	120.00 SF	0.00	171471	D	2000	Maintenance & Production	3	
MACDILL	3839	SHP CONVL MUN	120.00 SF	0.00	171471	D	2000	Maintenance & Production	3	
MACDILL	3842	SHP, SRVLL INSP	120.00 SF	0.00	111111	D	2000	Maintenance & Production	3	
MACDILL	3843	SHP, SRVLL INSP	120.00 SF	0.00	219946	D	2000	Maintenance & Production	3	
MACDILL	3846	SHP CONVL MUN	120.00 SF	0.00	219944	D	2000	Maintenance & Production	3	
MACDILL	3849	SHP CONVL MUN	120.00 SF	0.00	132135	D	2000	Maintenance & Production	3	
MACDILL	3874	VEH MAIN SHP	192.00 SF	0.00	179513	D	2000	Maintenance & Production	3	
MACDILL	3878	BE MAINT SHOP	120.00 SF	0.00	610913	D	2000	Maintenance & Production	3	**10830**
MACDILL	12	WHSE SUP&EQUIP BSE	3974.00 SF	0.00	610913	D	2001	Supply	5	
MACDILL	707	Hazardous Storage	403.00 SF	0.00	-46948	N	1998	Supply	5	
MACDILL	880	HAZARD STOR, BSE	625.00 SF	0.00	-101488	D	2001	Supply	5	
MACDILL	1107	WHSE SUP&EQUIP BSE	2431.00 SF	0.00	141456	D	2001	Supply	5	
MACDILL	1148	WHSE SUP&EQUIP BSE	5600.00 SF	0.00	126303	D	2001	Supply	5	
MACDILL	1149	WHSE SUP&EQUIP BSE	5600.00 SF	0.00	125791	D	2001	Supply	5	
MACDILL	3147	HSG SUP-STOR FCLTY	120.00 SF	0.00	125280	D	2000	Supply	5	
MACDILL	3151	HSG SUP-STOR FCLTY	120.00 SF	0.00	141153	D	2000	Supply	5	
MACDILL	3153	HSG SUP-STOR FCLTY	120.00 SF	0.00	151174	D	2000	Supply	5	
MACDILL	3170	WHSE SUP&EQUIP BSE	120.00 SF	0.00	132136	D	2000	Supply	5	
MACDILL	3172	WHSE SUP&EQUIP BSE	120.00 SF	0.00	179513	D	2000	Supply	5	
MACDILL	3251	HSG SUP-STOR FCLTY	120.00 SF	0.00	610913	D	2000	Supply	5	
MACDILL	3254	HSG SUP-STOR FCLTY	120.00 SF	0.00	610913	D	2000	Supply	5	
MACDILL	3258	HSG SUP-STOR FCLTY	120.00 SF	0.00	-46948	D	2000	Supply	5	
MACDILL	3259	HSG SUP-STOR FCLTY	120.00 SF	0.00	-101488	D	2000	Supply	5	
MACDILL	3371	WHSE SUP&EQUIP BSE	120.00 SF	0.00	141456	D	2000	Supply	5	
MACDILL	3374	WHSE,FORM &PUB,BSE	120.00 SF	0.00	126303	D	2000	Supply	5	
MACDILL	3375	HSG SUP-STOR FCLTY	120.00 SF	0.00	125791	D	2000	Supply	5	
MACDILL	3376	HSG SUP-STOR FCLTY	120.00 SF	0.00	125280	D	2000	Supply	5	
MACDILL	3378	HSG SUP-STOR FCLTY	120.00 SF	0.00	121111	D	2000	Supply	5	
MACDILL	3714	HSG SUP-STOR FCLTY	120.00 SF	0.00	131132	D	2000	Supply	5	
MACDILL	3862	WHSE SUP&EQUIP BSE	192.00 SF	0.00	149962	D	2000	Supply	5	
MACDILL	3863	WHSE SUP&EQUIP BSE	192.00 SF	0.00	134473	D	2000	Supply	5	
MACDILL	3864	WHSE SUP&EQUIP BSE	192.00 SF	0.00	124137	D	2000	Supply	5	
MACDILL	3865	WHSE SUP&EQUIP BSE	192.00 SF	0.00	179511	D	2000	Supply	5	
MACDILL	3866	WHSE SUP&EQUIP BSE	192.00 SF	0.00	141743	D	2000	Supply	5	
MACDILL	3868	WHSE SUP&EQUIP BSE	120.00 SF	0.00	131111	D	2000	Supply	5	
MACDILL	3869	WHSE SUP&EQUIP BSE	120.00 SF	0.00	131111	D	2000	Supply	5	
MACDILL	3870	WHSE SUP&EQUIP BSE	120.00 SF	0.00	131111	D	2000	Supply	5	

MACDILL	3871	WHSE SUP&EQUIP BSE	120.00 SF	0.00	131111	D	2000	Supply	5	
MACDILL	3872	WHSE SUP&EQUIP BSE	192.00 SF	0.00	610913	D	2000	Supply	5	
MACDILL	3873	WHSE SUP&EQUIP BSE	192.00 SF	0.00	131115	D	2000	Supply	5	
MACDILL	3886	WHSE SUP&EQUIP BSE	120.00 SF	0.00	610913	D	2000	Supply	5	**23289**
MACDILL	3711	MED COMD + ADMIN	120.00 SF	0.00	121111	D	2000	Medical	6	
MACDILL	3712	MED COMD + ADMIN	192.00 SF	0.00	134336	D	2000	Medical	6	
MACDILL	3926	PHARMACY	120.00 SF	0.00	121111	D	2000	Medical	6	**23361**
MACDILL	30	BASE ENGR ADMIN	19171.00 SF	0.00	121111	D	2001	Administration	7	
MACDILL	72	HQ GROUP	4000.00 SF	0.00	131114	D	1999	Administration	7	
MACDILL	172	ADMIN OFC,NON-AF	1347.00 SF	0.00	131111	D	2001	Administration	7	
MACDILL	176	VEH OPS ADMIN	1872.00 SF	0.00	131111	D	2001	Administration	7	
MACDILL	347	BASE ENGR ADMIN	3104.00 SF	0.00	171618	D	2001	Administration	7	
MACDILL	514	BILLBOARD	0.00 XX	1.00 EA	141165	D	2001	Administration	7	
MACDILL	544	FLAG POLE, BSE	0.00 XX	3.00 EA	141165	N	1999	Administration	7	
MACDILL	731	ADMIN OFC,NON-AF	2384.00 SF	0.00	171214	D	2001	Administration	7	
MACDILL	731	ADMIN OFC,NON-AF	1500.00 SF	0.00	171447	D	2001	Administration	7	
MACDILL	1105	HQ MAJOR COMD	23654.00 SF	0.00	131116	D	2001	Administration	7	
MACDILL	3009	HQ WG	120.00 SF	0.00	171471	D	2000	Administration	7	
MACDILL	3052	HQ WG	120.00 SF	0.00	171471	D	2000	Administration	7	
MACDILL	3054	WPN SYS/M MGT FCLT	120.00 SF	0.00	111111	D	2000	Administration	7	
MACDILL	3084	HQ GROUP	120.00 SF	0.00	219946	D	2000	Administration	7	
MACDILL	3085	HQ GROUP	192.00 SF	0.00	219944	D	2000	Administration	7	
MACDILL	3086	HQ GROUP	192.00 SF	0.00	132135	D	2000	Administration	7	
MACDILL	3087	HQ GROUP	192.00 SF	0.00	179514	D	2000	Administration	7	
MACDILL	3173	AFSOI OFFICE	120.00 SF	0.00	610913	D	2000	Administration	7	
MACDILL	3175	VEH OPS ADMIN	120.00 SF	0.00	610913	D	2000	Administration	7	
MACDILL	3176	VEH OPS ADMIN	120.00 SF	0.00	-156028	D	2000	Administration	7	
MACDILL	3177	VEH OPS ADMIN	120.00 SF	0.00	-210568	D	2000	Administration	7	
MACDILL	3205	HQ GROUP	120.00 SF	0.00	141457	D	2000	Administration	7	
MACDILL	3240	HQ WG	120.00 SF	0.00	124768	D	2000	Administration	7	
MACDILL	3845	HQ MAJOR COMD	192.00 SF	0.00	124257	D	2000	Administration	7	
MACDILL	3847	HQ MAJOR COMD	240.00 SF	0.00	123745	D	2000	Administration	7	
MACDILL	5307	BILLBOARD	0.00 XX	1.00 EA	161195	D	2001	Administration	7	**61424**
MACDILL	91	FR STN	2700.00 SF	1.00 ST	171216	D	1999	Community Support	8	
MACDILL	252	Education Cen - Library	35004.00 SF	0.00	132137	D	2001	Community Support	8	
MACDILL	259	DH, AMN (DET)	15093.00 SF	1200.00 PN	179514	D	2001	Community Support	8	
MACDILL	263	Dining FCLTY	18762.00 SF	0.00	610913	D	2001	Community Support	8	
MACDILL	370	CRT, RECTN	0.00 XX	2.00 EA	610913	D	2001	Community Support	8	
MACDILL	371	DORM, VAQ	8380.00 SF	12.00 PN	-156028	D	2001	Community Support	8	
MACDILL	384	CRT, RECTN	0.00 XX	1.00 EA	-210568	D	2001	Community Support	8	
MACDILL	391	CRT, TENNIS	0.00 XX	2.00 EA	141457	D	2001	Community Support	8	
MACDILL	395	CHILD DEV CENTER	21638.00 SF	0.00	124768	D	2000	Community Support	8	
MACDILL	397	OPEN MESS, OFF	30672.00 SF	0.00	124257	D	2001	Community Support	8	
MACDILL	447	BUS, SHLTR	108.00 SF	0.00	123745	D	2001	Community Support	8	

MACDILL	469	Misc Rectn Str	0.00 XX	1.00 EA	121111	D	2000	Community Support	8	
MACDILL	471	Bus Station	66.00 SF	0.00	131132	D	2000	Community Support	8	
MACDILL	483	Misc Rectn Str	0.00 XX	1.00 EA	149962	D	2000	Community Support	8	
MACDILL	507	MISC O/RECTN FCLTY	0.00 XX	1.00 EA	134473	N	1999	Community Support	8	
MACDILL	542	TRAFFIC CHK HSE	87.00 SF	0.00	124137	N	2000	Community Support	8	
MACDILL	545	MISC O/RECTN FCLTY	0.00 XX	1.00 EA	179511	N	1999	Community Support	8	
MACDILL	546	MONUMENTS/MEMORL	0.00 XX	5.00 EA	141743	N	1999	Community Support	8	
MACDILL	728	MWR SUP/NAF C-STOR	416.00 SF	0.00	131111	D	2001	Community Support	8	
MACDILL	731	MWR SUP/NAF C-STOR	884.00 SF	0.00	131111	D	2001	Community Support	8	
MACDILL	899	MISC O/RECTN FCLTY	0.00 XX	3.00 EA	131111	D	2001	Community Support	8	
MACDILL	908	BUS, SHLTR	52.00 SF	0.00	131111	D	2001	Community Support	8	
MACDILL	1095	TRAFFIC CHK HSE	86.00 SF	0.00	610913	D	2001	Community Support	8	
MACDILL	1706	GOLF/MAINT EQUIP	5000.00 SF	0.00	131115	N	2002	Community Support	8	
MACDILL	2009	MISC O/RECTN FCLTY	0.00 XX	1.00 EA	610913	D	2001	Community Support	8	
MACDILL	2010	MISC O/RECTN FCLTY	0.00 XX	1.00 EA	121111	D	2001	Community Support	8	
MACDILL	2018	MISC O/RECTN FCLTY	0.00 XX	1.00 EA	134336	D	2000	Community Support	8	
MACDILL	2019	MISC O/RECTN FCLTY	0.00 XX	1.00 EA	121111	D	2001	Community Support	8	
MACDILL	3126	SP OPERATIONS	120.00 SF	0.00	121111	D	2000	Community Support	8	
MACDILL	3298	MWR SUP/NAF C-STOR	120.00 SF	0.00	131114	D	2000	Community Support	8	
MACDILL	3303	GYMNASIUM	120.00 SF	0.00	131111	D	2000	Community Support	8	
MACDILL	3304	GYMNASIUM	120.00 SF	0.00	131111	D	2000	Community Support	8	
MACDILL	3311	RECTN, LIB	120.00 SF	0.00	171618	D	2000	Community Support	8	
MACDILL	3355	CHAPEL CEN	120.00 SF	1.00 SE	141165	D	2000	Community Support	8	
MACDILL	3364	MWR SUP/NAF C-STOR	120.00 SF	0.00	141165	D	2000	Community Support	8	
MACDILL	3365	MWR SUP/NAF C-STOR	120.00 SF	0.00	171214	D	2000	Community Support	8	
MACDILL	3366	MWR SUP/NAF C-STOR	120.00 SF	0.00	171447	D	2000	Community Support	8	
MACDILL	3367	MWR SUP/NAF C-STOR	120.00 SF	0.00	131116	D	2000	Community Support	8	
MACDILL	3380	CHILD CARE CEN	120.00 SF	0.00	171471	D	2000	Community Support	8	
MACDILL	3381	CHILD CARE CEN	120.00 SF	0.00	171471	D	2000	Community Support	8	
MACDILL	3382	CHILD CARE CEN	120.00 SF	0.00	111111	D	2000	Community Support	8	
MACDILL	3496	MWR SUP/NAF C-STOR	120.00 SF	0.00	219946	D	2000	Community Support	8	
MACDILL	3497	MWR SUP/NAF C-STOR	120.00 SF	0.00	219944	D	2000	Community Support	8	
MACDILL	3498	MWR SUP/NAF C-STOR	120.00 SF	0.00	132135	D	2000	Community Support	8	
MACDILL	3499	MWR SUP/NAF C-STOR	120.00 SF	0.00	179515	D	2000	Community Support	8	
MACDILL	3698	MWR SUP/NAF C-STOR	120.00 SF	0.00	610913	D	2000	Community Support	8	
MACDILL	3701	MWR SUP/NAF C-STOR	120.00 SF	0.00	610913	D	2000	Community Support	8	
MACDILL	3704	MWR SUP/NAF C-STOR	120.00 SF	0.00	-265108	D	2000	Community Support	8	
MACDILL	3824	SP KENNEL SPT BLDG	120.00 SF	0.00	-319648	D	2000	Community Support	8	
MACDILL	3892	TRN LODGE SPT BLDG	120.00 SF	0.00	141458	D	2000	Community Support	8	
MACDILL	3905	TRN LODGE SPT BLDG	120.00 SF	0.00	123234	D	2000	Community Support	8	**141708**
MACDILL	398	GARGE FAM HSG DET	1941.00 SF	6.00 VE	122722	D	2001	Housing	9	
MACDILL	454	FAM Hsg	2894.00 SF	0.00	122211	D	2000	Housing	9	
MACDILL	456	FAM Hsg	2894.00 SF	0.00	181237	D	2000	Housing	9	
MACDILL	457	FAM Hsg	2894.00 SF	0.00	191258	D	2000	Housing	9	

MACDILL	458	FAM Hsg	2894.00 SF	0.00	132138	D	2000	Housing	9	
MACDILL	459	FAM Hsg	2894.00 SF	0.00	179515	D	2000	Housing	9	
MACDILL	460	FAM Hsg	2894.00 SF	0.00	610913	D	2000	Housing	9	
MACDILL	461	FAM Hsg	2894.00 SF	0.00	610913	D	2000	Housing	9	
MACDILL	462	FAM Hsg	2894.00 SF	0.00	-265108	D	2000	Housing	9	
MACDILL	463	FAM Hsg	2894.00 SF	0.00	-319648	D	2000	Housing	9	
MACDILL	464	FAM Hsg	2894.00 SF	0.00	141458	D	2000	Housing	9	
MACDILL	465	FAM Hsg	2894.00 SF	0.00	123234	D	2000	Housing	9	
MACDILL	466	FAM Hsg	2894.00 SF	0.00	122722	D	2000	Housing	9	
MACDILL	472	FAM Hsg	2894.00 SF	0.00	122211	D	2000	Housing	9	
MACDILL	473	FAM Hsg	2894.00 SF	0.00	121111	D	2000	Housing	9	
MACDILL	474	FAM Hsg	2894.00 SF	0.00	131132	D	2000	Housing	9	
MACDILL	475	FAM Hsg	2894.00 SF	0.00	149962	D	2000	Housing	9	
MACDILL	476	FAM Hsg	2894.00 SF	0.00	134473	D	2000	Housing	9	
MACDILL	477	FAM Hsg	2894.00 SF	0.00	124137	D	2000	Housing	9	
MACDILL	479	FAM Hsg	2894.00 SF	0.00	179511	D	2000	Housing	9	
MACDILL	480	FAM Hsg	2894.00 SF	0.00	141743	D	2000	Housing	9	
MACDILL	481	FAM Hsg	2894.00 SF	0.00	131111	D	2000	Housing	9	
MACDILL	482	FAM Hsg	2894.00 SF	0.00	131111	D	2000	Housing	9	
MACDILL	485	FAM Hsg	2894.00 SF	0.00	131111	D	2000	Housing	9	
MACDILL	486	FAM Hsg	2894.00 SF	0.00	131111	D	2000	Housing	9	
MACDILL	487	FAM Hsg	2894.00 SF	0.00	610913	D	2000	Housing	9	
MACDILL	488	FAM Hsg	2894.00 SF	0.00	131115	D	2000	Housing	9	
MACDILL	489	FAM Hsg	2894.00 SF	0.00	610913	D	2000	Housing	9	
MACDILL	490	FAM Hsg	2894.00 SF	0.00	121111	N	2000	Housing	9	
MACDILL	622	FAM HSG, WHERRY	5499.00 SF	4.00 FA	134336	D	2000	Housing	9	
MACDILL	624	FAM HSG, WHERRY	5499.00 SF	4.00 FA	121111	D	2000	Housing	9	
MACDILL	900	TLR CRT PARKING	0.00 XX	100.00 FA	121111	D	2000	Housing	9	**93971**
MACDILL	371	DORM AM PP/PCS-STD	25142.00 SF	88.00 PN	131114	D	2001	Dormitories	10	
MACDILL	371	DORM AM PP/PCS-STD	16762.00 SF	88.00 PN	131111	D	2001	Dormitories	10	**41904**
MACDILL	19	ELEC SUBSTATION	0.00 XX	1000.00 KV	131111	D	2001	UGI	11	
MACDILL	450	SAN SEW PUMP Stn	105.00 SF	0.00	171618	D	1999	UGI	11	
MACDILL	547	SPT STRU	0.00 XX	5.00 EA	141165	N	1999	UGI	11	
MACDILL	682	Marina Bay Café	6375.00 SF	0.00	141165	N	2001	UGI	11	
MACDILL	885	S/WASTE REPOSITORY	1350.00 SF	0.00	171214	N	2000	UGI	11	
MACDILL	891	SAN SEW PUMP Stn	200.00 SF	0.00	171447	N	2002	UGI	11	
MACDILL	1078	IND WST FL-SP COLL	0.00 XX	12.00 KG	131116	D	2001	UGI	11	
MACDILL	1180	ELEC E/PWR GEN PLT	0.00 XX	15.00 KW	171471	D	2000	UGI	11	
MACDILL	1181	ELEC E/PWR GEN PLT	0.00 XX	15.00 KW	171471	D	2000	UGI	11	
MACDILL	1249	RR TRACKAGE	0.00 XX	2100.00 LF	111111	D	2001	UGI	11	
MACDILL	1267	FENCE, INTERIOR	0.00 XX	2593.00 LF	132135	D	2001	UGI	11	
MACDILL	1282	LOAD&UNLOAD PLATFM	1296.00 SF	0.00	179512	D	2001	UGI	11	
MACDILL	3066	WST TRMT BLDG	120.00 SF	0.00	610913	D	2000	UGI	11	**9446**

BARKSDALE AIR FORCE BASE CHANGED FEATURES

INSTL_ NAME_40	FACT_ ID_NR	CAT_ NOMENCLATURE	RP_AREA _AMT	AREA _U0M	RP_OTH _AMT	OTH _U0M	RP_CAT _PRES	TYPE	YR_ COMP	IRR Category	Coding	Subtotal
BARKSDALE	4560	RES COMP MED	4776.00	SF	0.00		171450	A	N/A	Operations & Training	1	
BARKSDALE	6060	CEILOMETER	0.00	XX	1.00	EA	149622	D	N/A	Operations & Training	1	
BARKSDALE	6101	CEILOMETER	0.00	XX	1.00	EA	149622	D	N/A	Operations & Training	1	
BARKSDALE	7068	DISASTER PREP	1104.00	SF	0.00		610913	D	N/A	Operations & Training	1	
BARKSDALE	7480	BUNKER	0.00	XX	1.00	EA	149411	D	N/A	Operations & Training	1	
BARKSDALE	7500	COMM FCLTY	15000.00	SF	0.00		131111	A	N/A	Operations & Training	1	
BARKSDALE	66431	OPG STOR, JET FL	0.00	XX	50000.00	GA	124135	D	N/A	Operations & Training	1	
BARKSDALE	66432	OPG STOR, JET FL	0.00	XX	50000.00	GA	124135	D	N/A	Operations & Training	1	
BARKSDALE	66433	OPG STOR, JET FL	0.00	XX	50000.00	GA	124135	D	N/A	Operations & Training	1	
BARKSDALE	66434	OPG STOR, JET FL	0.00	XX	50000.00	GA	124135	D	N/A	Operations & Training	1	
BARKSDALE	66435	OPG STOR, JET FL	0.00	XX	50000.00	GA	124135	D	N/A	Operations & Training	1	
BARKSDALE	66436	OPG STOR, JET FL	0.00	XX	50000.00	GA	124135	D	N/A	Operations & Training	1	
BARKSDALE	66551	OPG STOR, JET FL	0.00	XX	50000.00	GA	124135	D	N/A	Operations & Training	1	
BARKSDALE	66552	OPG STOR, JET FL	0.00	XX	50000.00	GA	124135	D	N/A	Operations & Training	1	
BARKSDALE	66553	OPG STOR, JET FL	0.00	XX	50000.00	GA	124135	D	N/A	Operations & Training	1	
BARKSDALE	66554	OPG STOR, JET FL	0.00	XX	50000.00	GA	124135	D	N/A	Operations & Training	1	
BARKSDALE	97307	PAD EQUIP	19.00	SY	1.00	EA	132133	A	N/A	Operations & Training	1	
BARKSDALE	99744	ILS LOCALIZER	64.00	SF	1.00	EA	134353	D	N/A	Operations & Training	1	
BARKSDALE	99745	ILS GLIDE SLOPE	64.00	SF	1.00	EA	134351	D	N/A	Operations & Training	1	
BARKSDALE	99746	ILS LOCALIZER	64.00	SF	1.00	EA	134353	D	N/A	Operations & Training	1	
BARKSDALE	99747	ILS GLIDE SLOPE	64.00	SF	1.00	EA	134351	D	N/A	Operations & Training	1	
BARKSDALE	99749	ILS MARKER	64.00	SF	1.00	EA	134355	D	N/A	Operations & Training	1	21219
BARKSDALE	4156	VEH SVC RACK	600.00	SF	1.00	EA	214422	D	N/A	Maintenance and Production	2	
BARKSDALE	4158	VEH SVC RACK	1800.00	SF	1.00	EA	214422	D	N/A	Maintenance and Production	2	
BARKSDALE	4178	VEH MAIN SHP	120.00	SF	0.00		214425	D	N/A	Maintenance and Production	2	
BARKSDALE	4443	BE STOR SHED	800.00	SF	0.00		219947	D	N/A	Maintenance and Production	2	
BARKSDALE	6203	SHP A/M ORGL	13265.00	SF	0.00		211154	D	N/A	Maintenance and Production	2	
BARKSDALE	6213	MAINT DOCK, L/A	20000.00	SF	1.00	EA	211173	D	N/A	Maintenance and Production	2	
BARKSDALE	7285	BE MAINT SHOP	832.00	SF	0.00		219944	D	N/A	Maintenance and Production	2	
BARKSDALE	7574	SHP MSL WH ASMB	6944.00	SF	0.00		212217	A	N/A	Maintenance and Production	2	
BARKSDALE	7663	BE STOR CV FCTLY	300.00	SF	0.00		219946	D	N/A	Maintenance and Production	2	44661
BARKSDALE	4743	SHED SUP&EQUIP	2400.00	SF	0.00		442628	D	N/A	Supply	5	
BARKSDALE	6637	STOR LIQ OXYGEN	1295.00	SF	0.00		442258	D	N/A	Supply	5	
BARKSDALE	7275	HAZARD STOR, BSE	240.00	SF	0.00		442257	D	N/A	Supply	5	
BARKSDALE	7447	STOR, IGLOO	807.00	SF	1.00	EA	422264	D	N/A	Supply	5	
BARKSDALE	7561	STOR SPARE INERT	1013.00	SF	0.00		422265	D	N/A	Supply	5	
BARKSDALE	7704	STOR SPARE INERT	14308.00	SF	0.00		422265	A	N/A	Supply	5	20063
BARKSDALE	4355	MED STOR (WRM)	4824.00	SF	0.00		442515	D	N/A	Medical	6	4824

BARKSDALE	7294	WPN SYS/M MGT	2160.00	SF	0.00		610129	D	N/A	Administration	7	
BARKSDALE	7306	MUN MAINT	6096.00	SF	0.00		610144	A	N/A	Administration	7	
BARKSDALE	7418	WPN SYS/M MGT	3294.00	SF	0.00		610129	D	N/A	Administration	7	
BARKSDALE	7428	WPN SYS/M MGT	3992.00	SF	0.00		610129	D	N/A	Administration	7	
BARKSDALE	7560	MUN MAINT	4800.00	SF	0.00		610144	A	N/A	Administration	7	25166
BARKSDALE	2923	CRT, TENNIS	0.00	XX	2.00	EA	750347	D	N/A	Community Support	8	
BARKSDALE	4344	THRIFT SHP	6140.00	SF	0.00		740255	D	N/A	Community Support	8	
BARKSDALE	4344	OPEN MESS, AMN	14653.00	SF	0.00		740612	D	N/A	Community Support	8	
BARKSDALE	4344	OPEN MESS, AMN	7721.00	SF	0.00		740612	D	N/A	Community Support	8	
BARKSDALE	4355	POST OFFICE CEN	1530.00	SF	0.00		730443	D	N/A	Community Support	8	
BARKSDALE	4355	ARTS&CRAFTS	13923.00	SF	0.00		740664	D	N/A	Community Support	8	
BARKSDALE	4355	ARTS&CRAFTS	7569.00	SF	0.00		740664	D	N/A	Community Support	8	
BARKSDALE	6016	O/D RECTN	768.00	SF	1.00	EA	750371	A	N/A	Community Support	8	
BARKSDALE	6040	O/D RECTN	320.00	SF	1.00	EA	750371	D	N/A	Community Support	8	
BARKSDALE	6042	O/D RECTN	320.00	SF	1.00	EA	750371	D	N/A	Community Support	8	
BARKSDALE	6065	SWIM POOL	648.00	SF	0.00		750812	D	N/A	Community Support	8	
BARKSDALE	6252	SP OPERATIONS	2080.00	SF	0.00		730835	D	N/A	Community Support	8	
BARKSDALE	7235	DH, AMN (DET)	18220.00	SF	200.00	PN	722351	D	N/A	Community Support	8	
BARKSDALE	7307	RES FR TEAM	3057.00	SF	0.00		730836	A	N/A	Community Support	8	
BARKSDALE	7449	RES FR TEAM	1500.00	SF	0.00		730836	D	N/A	Community Support	8	
BARKSDALE	8129	O/D RECTN	420.00	SF	1.00	EA	750371	D	N/A	Community Support	8	
BARKSDALE	8940	SAN LATRINE	36.00	SF	0.00		723392	D	N/A	Community Support	8	
BARKSDALE	53625	MISC O/RECTN	0.00	XX	6.00	EA	750581	A	N/A	Community Support	8	
BARKSDALE	58088	MISC O/RECTN	0.00	XX	1.00	EA	750581	A	N/A	Community Support	8	
BARKSDALE	59000	MISC O/RECTN	0.00	XX	3.00	EA	750581	A	N/A	Community Support	8	
BARKSDALE	99017	MONUMENTS/MEM	0.00	XX	1.00	EA	760512	A	N/A	Community Support	8	78905
BARKSDALE	2220	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	2222	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	2224	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9	
BARKSDALE	2500	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	2502	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9	
BARKSDALE	2504	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	2506	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	2508	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	2510	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9	
BARKSDALE	2600	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	2602	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9	
BARKSDALE	2604	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	2606	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	2608	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9	
BARKSDALE	2610	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	2612	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	2614	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9	
BARKSDALE	2616	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	2618	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	2620	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9	

BARKSDALE	2622	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2624	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2626	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2630	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	2702	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	2704	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2706	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2708	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	2710	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2712	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2718	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	2720	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2724	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2726	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	2728	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2730	GARGE FAM HSG	633.00	SF	2.00	VE	714431	A	N/A	Housing	9
BARKSDALE	2732	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2734	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2736	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	2738	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2740	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2742	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	2744	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2746	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2748	GARGE FAM HSG	633.00	SF	2.00	VE	714431	A	N/A	Housing	9
BARKSDALE	2750	FAM HSG APPR	3292.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2753	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2758	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	2759	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2761	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2763	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	2769	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2773	GARGE FAM HSG	633.00	SF	2.00	VE	714431	A	N/A	Housing	9
BARKSDALE	2800	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2801	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2802	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2803	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	2804	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	2805	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2806	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2807	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	2809	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	2810	GARGE FAM HSG	633.00	SF	2.00	VE	714431	A	N/A	Housing	9
BARKSDALE	2811	FAM HSG APPR	3261.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3125	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3131	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9

BARKSDALE	3133	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3137	GARGE FAM HSG	633.00	SF	2.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3230	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3232	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3234	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3246	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3247	GARGE FAM HSG	633.00	SF	2.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3342	GARGE FAM HSG	633.00	SF	2.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3460	FAM HSG APPR	3522.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3461	FAM HSG APPR	3522.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3462	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3463	GARGE FAM HSG	633.00	SF	2.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3464	FAM HSG APPR	3522.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3468	FAM HSG APPR	3522.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3470	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3471	FAM HSG APPR	3522.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3472	FAM HSG APPR	3522.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3473	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3474	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3475	FAM HSG APPR	3522.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3476	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3479	FAM HSG APPR	3522.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3483	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3485	FAM HSG APPR	3522.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3489	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3491	FAM HSG APPR	3522.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3499	FAM HSG APPR	3522.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3559	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3565	FAM HSG APPR	3522.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3567	FAM HSG APPR	3522.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3600	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3602	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3604	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3606	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3608	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3610	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3612	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3614	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3616	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3618	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3619	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3620	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3621	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3622	GARGE FAM HSG	633.00	SF	2.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3623	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3624	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9

BARKSDALE	3625	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3626	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3627	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3628	GARGE FAM HSG	633.00	SF	2.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3629	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3630	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3631	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3632	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3633	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3636	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3637	GARGE FAM HSG	633.00	SF	2.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3638	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3639	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3640	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3732	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3734	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3736	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3738	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3754	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3756	GARGE FAM HSG	1260.00	SF	4.00	VE	714431	A	N/A	Housing	9
BARKSDALE	3758	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	3760	FAM HSG APPR	3071.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9030	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9031	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9032	FAM HSG APPR	3048.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9033	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9035	FAM HSG APPR	3048.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9038	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9039	FAM HSG APPR	3398.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9040	FAM HSG APPR	3398.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9041	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9042	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9043	FAM HSG APPR	3398.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9044	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9045	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9046	FAM HSG APPR	3398.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9047	FAM HSG APPR	3398.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9048	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9049	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9051	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9053	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9054	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9055	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9056	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9057	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9
BARKSDALE	9058	FAM HSG APPR	3048.00	SF	2.00	FA	711142	A	N/A	Housing	9

BARKSDALE	9100	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	9101	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	9102	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	9103	FAM HSG APPR	2614.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	9104	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	9105	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	9106	FAM HSG APPR	3398.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	9107	FAM HSG APPR	3398.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	9108	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	9109	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	9110	FAM HSG APPR	3398.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	9111	FAM HSG APPR	2730.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	9112	FAM HSG APPR	3048.00	SF	2.00	FA	711142	A	N/A	Housing	9	
BARKSDALE	9113	FAM HSG APPR	3398.00	SF	2.00	FA	711142	A	N/A	Housing	9	441059
BARKSDALE	4344	AIR COND PLT	792.00	SF	0.00		890123	D	N/A	UGI	11	
BARKSDALE	6435	BLDG WTR SUP	597.00	SF	0.00		841169	D	N/A	UGI	11	
BARKSDALE	6439	SPT STRU	0.00	XX	1.00	EA	890161	A	N/A	UGI	11	
BARKSDALE	7125	LOAD & UNLOAD G·	0.00	XX	1.00	EA	890154	D	N/A	UGI	11	
BARKSDALE	7260	WTR PMP STN	140.00	SF	0.00		842249	D	N/A	UGI	11	
BARKSDALE	7439	DSPL RADACT WST	10000.00	SF	1.00	KG	831172	D	N/A	UGI	11	
BARKSDALE	7661	SPT STRU	0.00	XX	1.00	EA	890161	A	N/A	UGI	11	
BARKSDALE	7824	BLDG WTR SUP	198.00	SF	0.00		841169	D	N/A	UGI	11	
BARKSDALE	8076	FR PROTEC WTR	0.00	XX	250000.00	KG	843319	A	N/A	UGI	11	
BARKSDALE	8078	BLDG WTR SUP	432.00	SF	0.00		841169	A	N/A	UGI	11	
BARKSDALE	36214	MISC STOR TANK	0.00	XX	1190.00	BL	890171	A	N/A	UGI	11	
BARKSDALE	37297	IND WST FL-SP	0.00	XX	528.00	KG	831157	A	N/A	UGI	11	
BARKSDALE	87306	ELEC SUBSTATION	0.00	XX	95.00	KV	813231	A	N/A	UGI	11	
BARKSDALE	87500	ELEC SUBSTATION	0.00	XX	15.00	KV	813231	A	N/A	UGI	11	
BARKSDALE	97306	WALKWAY, CV	20.00	SY	0.00		852287	A	N/A	UGI	11	
BARKSDALE	97500	SAN SEWAGE PMP	38.00	SF	0.00		832267	A	N/A	UGI	11	
BARKSDALE	99000	PRIM DISTR LNE	0.00	XX	2400.00	LF	812223	A	N/A	UGI	11	
BARKSDALE	99001	PRIM DISTR LNE	0.00	XX	14100.00	LF	812225	A	N/A	UGI	11	
BARKSDALE	99002	SEC DISTR LNE UG	0.00	XX	27200.00	LF	812226	A	N/A	UGI	11	
BARKSDALE	99003	EXTERIOR AREA	0.00	XX	23.00	EA	812926	A	N/A	UGI	11	
BARKSDALE	99004	GAS METER FCLTY	182.00	SF	0.00		824462	A	N/A	UGI	11	
BARKSDALE	99005	GAS MAINS	0.00	XX	16049.00	LF	824464	A	N/A	UGI	11	
BARKSDALE	99006	SAN SEWAGE MAIN	0.00	XX	35600.00	LF	832266	A	N/A	UGI	11	
BARKSDALE	99007	SAN SEWAGE PMP	2250.00	SF	0.00		832267	A	N/A	UGI	11	
BARKSDALE	99008	WTR DISTR MAINS	0.00	XX	58205.00	LF	842245	A	N/A	UGI	11	
BARKSDALE	99009	FR HYDR	0.00	XX	7.00	EA	843315	A	N/A	UGI	11	
BARKSDALE	99011	CURBS & GUTTERS	0.00	XX	22278.00	LF	851143	A	N/A	UGI	11	
BARKSDALE	99012	DRIVEWAY	6800.00	SY	0.00		851145	A	N/A	UGI	11	
BARKSDALE	99013	ROAD	45704.00	SY	17139.00	LF	851147	A	N/A	UGI	11	
BARKSDALE	99014	SIDEWALK	7067.00	SY	0.00		852289	A	N/A	UGI	11	
BARKSDALE	99015	STRM DRN DSPL	0.00	XX	1445.00	LF	871183	A	N/A	UGI	11	
BARKSDALE	99016	FENCE, INTERIOR	0.00	XX	1268.00	LF	872248	A	N/A	UGI	11	74220

Appendix B: Category Weighting Questionnaire

This appendix includes the three pages sent to the PACAF MAJCOM Deputy Civil Engineer. Colonel William Drake was requested to answer two different questions in an effort to develop the different weightings used in the research. Each page is briefly described below:

- Introduction Letter: Sent to introduce researcher, summarize the research and the purpose of the questions.
- Question One: Instructs reader to rank-order the following twelve categories
- Question Two: Instructs reader to score each category on a scale of 1 – 10 (1 = lowest – 10 = highest)

6 Jan 03

Col William Drake
25 E St
Hickam, HI 96853-5418

Dear Col Drake

Thank you for taking the time to assist me in my thesis effort. My thesis, the development of a mathematical model to be used by GeoBase personnel in determining optimal refreshment times of an installation's digital imagery, is almost complete. As the installation changes over time (buildings demolished and constructed, etc), the **digital imagery** does not change, thus becoming more inaccurate over time. Unlike other GeoBase layers, the digital imagery is not updated for each facility change; rather it can only be updated by acquiring new imagery, which is a costly process. My model attempts to capture the amount of change of the installation to its imagery. Changes can include facilities, pavements, terrain, trees, and any other aboveground features.

I am trying to develop a weighting system for each feature to more accurately represent the importance of the feature. For example, a command post facility may be considered more important than a transportation warehouse. Instead of rating each facility or feature, I have grouped them all into twelve categories. Eleven categories are the Installation Readiness Report categories (Community and Housing broken into three subcategories). The last category is environmental. Features that do not have a category code are placed into this category.

Your responses to the following questions will be used to determine relative weightings among the different categories. The values that you choose will be combined and normalized to determine a relative ranking. Your answers will be used as representative of your command, not the entire Air Force. I am proposing in my thesis that each command develops their own rankings thorough a more in-depth process similar to this one.

When answering the questions, please consider the perspective of the installation using the GeoBase map (including the **digital imagery**) for everyday functions and crisis management. I can be contacted at my home phone (937) XXX-XXXX at your convenience. Please complete the two questions and email back.

Sincerely,

//SIGNED//

MATTHEW S. CRAIG, Capt, USAF

Question 1: (1=Highest – 12=Lowest)

Each category represents a grouping of facilities or features with similar qualities. This question asks you to prioritize each of the following 12 categories (i.e., rank order).

INSTRUCTIONS:
Rank order the following categories from 1 to 12 where a rank of 1 represents the category that you believe is most important and a rank of 12 represents the category you feel is least important.

Each number may only be used once and all numbers must be used.

Example: Football Team Performance (My opinion based on last season -- I am from RI)
_**1**__ New England Patriots *(best)*
_**3**__ Detroit Lions *(second worst)*
_**4**__ Cincinnati Bengals *(worst)*
_**2**__ St Louis Rams *(second best)*

____ Operations and Training (airfield, radar, fuel storage, fire station)

____ Mobility (Air Freight/Passenger Terminal, Deploy/Depot Material Processing)

____ Maintenance and Production (Aircraft and vehicle maint/repair/production shops)

____ Research, Development, Testing, and Evaluation (Labs, Research, Wind tunnel)

____ Supply (Storage (MOGAS/solvent storage, Supplies/equip sheds)

____ Medical (Medical services/clinics, Medical labs)

____ Administrative (Admin, Headquarters office)

____ Community Support (Dining hall, Education center, Base Laundry, Schools)

____ MFH (Family Housing, Leased Family Housing, Trailer court)

____ Dormitories (Recruit/Cadet Quarters, other dormitories)

____ U&GI (Heating/Treatment plant, electric station, roads, sidewalks, land)

____ Environmental (trees, natural terrain, lakes, rivers)

Question 2: (1=lowest – 10=highest)

Each category represents a grouping of facilities or features with similar qualities. While similar to Question 1, this question allows the relative weights of the categories to be determined (i.e., a score of 10 is twice as important as a score of 5). It also allows for categories to be weighted equally, if desired.

INSTRUCTIONS:
Assign each of the following categories a value ranging from 1 to 10 where a score of 10 represents the category that you believe is most important and a score of 1 represents the category you feel is least important.

Assign only one category a value of 10 and only one category a value of 1; however, feel free to use the other values more than once (i.e., you may score three categories as a 5).

<u>Example:</u> Football Team Performance
_**10**_ New England Patriots
__**3**_ Detroit Lions
__**1**_ Cincinnati Bengals
__**9**_ St Louis Rams
__**3**_ Dallas Cowboys

____ Operations and Training (airfield, radar, fuel storage, fire station)

____ Mobility (Air Freight/Passenger Terminal, Deploy/Depot Material Processing)

____ Maintenance and Production (Aircraft and vehicle maint/repair/production shops)

____ Research, Development, Testing, and Evaluation (Labs, Research, Wind tunnel)

____ Supply (Storage (MOGAS/solvent storage, Supplies/equip sheds)

____ Medical (Medical services/clinics, Medical labs)

____ Administrative (Admin, Headquarters office)

____ Community Support (Dining hall, Education center, Base Laundry, Schools)

____ MFH (Family Housing, Leased Family Housing, Trailer court)

____ Dormitories (Recruit/Cadet Quarters, other dormitories)

____ U&GI (Heating/Treatment plant, electric station, roads, sidewalks, land)

____ Environmental (trees, natural terrain, lakes, rivers)

Appendix C: Questionnaire Results

This appendix identifies Col William Drake's responses to the questionnaire. His answers were based on his opinion of the value of each category to the PACAF installation mission.

Question 1:

(1=Highest – 12=Lowest)

Each category represents a grouping of facilities or features with similar qualities. This question asks you to prioritize each of the following 12 categories (i.e., rank order).

INSTRUCTIONS:
Rank order the following categories from 1 to 12 where a rank of 1 represents the category that you believe is most important and a rank of 12 represents the category you feel is least important.

Each number may only be used once and all numbers must be used.

Example: Football Team Performance (My opinion based on last season -- I am from RI)
_**1**__ New England Patriots *(best)*
_**3**__ Detroit Lions *(second worst)*
_**4**__ Cincinnati Bengals *(worst)*
_**2**__ St Louis Rams *(second best)*

Considering the ultimate mission of PACAF installations is to generate and recover sorties, I would judge the relative importance of these facility groups to be as follows, with rationale as given:

__1_ Operations and Training (airfield, radar, fuel storage, fire station)

- Without an airfield and related facilities, including fuel storage, we can't generate or recover sorties.

__5_ Mobility (Air Freight/Passenger Terminal, Deploy/Depot Material Processing)

- Freight and passengers can be processed without a facility, but it's safer and more efficient to have permanent facilities.

__2_ Maintenance and Production (Aircraft and vehicle maint/repair/production shops)

- As we become more and more dependent on high tech and specialized equipment, some maintenance/production activities are dependent on real property facilities.

_11_ Research, Development, Testing, and Evaluation (Labs, Research, Wind tunnel)

- Necessary for future sortie generation, but not for current ops.

__6_ Supply (Storage (MOGAS/solvent storage, Supplies/equip sheds)

- Supplies can be stored and issued outdoors or in portable buildings, but it's safer and more efficient to have permanent facilities.

__4_ Medical (Medical services/clinics, Medical labs)

- We can work around not having fixed medical facilities, but maintenance/repair of air crews and mission generators is heavily dependent on fixed facilities.

__8_ Administrative (Admin, Headquarters office)

- Permanent administrative facilities are not necessary for sortie generation, but they improve efficiency.

__7_ Community Support (Dining hall, Education center, Base Laundry, Schools)

- Food can be served cold in work areas or from expedient facilities, but a permanent dining facility is more efficient and enhances readiness.

_10_ MFH (Family Housing, Leased Family Housing, Trailer court)

- The AF does not have to be in the family housing business; 60% of AF members live off base in private sector housing, and the percent could rise without affecting operations.

__9_ Dormitories (Recruit/Cadet Quarters, other dormitories)

- As a matter of policy, on-base housing is required for our youngest airmen, though it could be in the form of non-real property (tents).

__3_ U&GI (Heating/Treatment plant, electric station, roads, sidewalks, land)

- Land (bombing ranges and drop zones) is essential for maintaining readiness. We can work around having real property utility systems; but every element of mission support depends on utilities, and expedient utility systems are labor

intensive and inefficient. This would be my rank for this group even if ranges/drop zones fall in Ops & Trng.

_12_ Environmental (trees, natural terrain, lakes, rivers)

- Sortie generation and recovery are not dependent on aesthetics, but a pleasant, responsibly maintained environment is nice to have.

Question 2: (1=lowest – 10=highest)

Each category represents a grouping of facilities or features with similar qualities. While similar to Question 1, this question allows the relative weights of the categories to be determined (i.e., a score of 10 is twice as important as a score of 5). It also allows for categories to be weighted equally, if desired.

INSTRUCTIONS:
Assign each of the following categories a value ranging from 1 to 10 where a score of 10 represents the category that you believe is most important and a score of 1 represents the category you feel is least important.

Assign only one category a value of 10 and only one category a value of 1; however, feel free to use the other values more than once (i.e., you may score three categories as a 5).

<u>Example:</u> Football Team Performance
_**10**_ New England Patriots
__**3**_ Detroit Lions
__**1**_ Cincinnati Bengals
__**9**_ St Louis Rams
__**3**_ Dallas Cowboys

_10_ Operations and Training (airfield, radar, fuel storage, fire station)

__7_ Mobility (Air Freight/Passenger Terminal, Deploy/Depot Material Processing)

__8_ Maintenance and Production (Aircraft and vehicle maint/repair/production shops)

__2_ Research, Development, Testing, and Evaluation (Labs, Research, Wind tunnel)

__7_ Supply (Storage (MOGAS/solvent storage, Supplies/equip sheds)

__8_ Medical (Medical services/clinics, Medical labs)

__6_ Administrative (Admin, Headquarters office)

__6_ Community Support (Dining hall, Education center, Base Laundry, Schools)

__3_ MFH (Family Housing, Leased Family Housing, Trailer court)

__6_ Dormitories (Recruit/Cadet Quarters, other dormitories)

__8_ U&GI (Heating/Treatment plant, electric station, roads, sidewalks, land)

__1_ Environmental (trees, natural terrain, lakes, rivers)

Appendix D: Decision Analysis Model for Refreshment of GeoBase Imagery

A decision analysis model was developed to aid the MAJCOMs in developing a strategic investment plan for maintaining current installation imagery. This decision model based on the square footage of changes to the installation can provide guidance to the MAJCOM on determining their installations' GeoBase imagery refreshment. The model can be broken into two main parts: reporting process and change value. The reporting process is developed by the MAJCOMs. After the reporting process is determined, each installation can calculate its change value using the model and develop a report to send to the MAJCOM.

This appendix contains step-by-step instructions for the MAJCOM for implementation of the installation reporting process. The instructions are broken into two stages: Determining the Category Weights and Develop Requirements. Appendix E: Installation Instruction Booklet provides information on the report format. These suggestions are meant to provide guidance for the MAJCOM.

MAJCOM INSTRUCTION SHEET

STAGE 1: DETERMINING THE CATEGORY WEIGHTS

1. Rank-Order Categories

This step involves prioritizing each of the following 12 categories. Rank order the following categories from 1 to 12 where a rank of 1 represents the category that you believe is most important and a rank of 12 represents the category you feel is least important. Each number may only be used once and all numbers must be used. Suggested MAJCOM personnel to rank the categories are the MAJCOM Commander and the Civil Engineering Commander.

____ Operations and Training (airfield, radar, fuel storage, fire station)
____ Mobility (Air Freight/Passenger Terminal, Deploy/Depot Material Processing)
____ Maintenance and Production (Aircraft and vehicle maint/repair/production shops)
____ Research, Development, Testing, and Evaluation (Labs, Research, Wind tunnel)
____ Supply (Storage (MOGAS/solvent storage, Supplies/equip sheds)
____ Medical (Medical services/clinics, Medical labs)
____ Administrative (Admin, Headquarters office)
____ Community Support (Dining hall, Education center, Base Laundry, Schools)
____ MFH (Family Housing, Leased Family Housing, Trailer court)
____ Dormitories (Recruit/Cadet Quarters, other dormitories)
____ U&GI (Heating/Treatment plant, electric station, roads, sidewalks, land)
____ Environmental (trees, natural terrain, lakes, rivers)

2. Place each category next to the assigned rank from above

Position Rank	Weight	Category
1	37	
2	25	
3	19	
4	15	
5	12	
6	10	
7	8	
8	6	
9	5	
10	3	
11	2	
12	1	

Each category now has been assigned a weighted value to be distributed to the installations. An example is shown in Appendix F. These category weights are to be used when the number of categories equals twelve. When the number of categories is different from twelve, Equation 2 in Chapter Four must be used in determined the category weights.

STAGE 2: DEVELOP REQUIREMENTS

1. Timeline

Timeline should provide an overview of the imagery refreshment process for the installations. Factors to consider include budgeting procedures, GeoBase funding process, and end-of-year fallout funds.

The timeline should include submittal deadlines for the installation.

Timeline should include decision dates of the MAJCOM.

2. Reporting Chain

The installation report is developed by the installation GeoBase personnel. Proper routing of the report ensures the proper personnel at the installation and the MAJCOM are informed of the process and results.

The reporting chain could include the Base Civil Engineer, Mission Support Group, and the installation or wing commander at the installation. The report should be sent to the MAJCOM in accordance with their guidance.

3. MAJCOM Decision Process

Each installation should be informed of the decision and prioritization process used by the MAJCOM. Each MAJCOM should identify each factor used in determining the priority list of the installations. Suggested factors should include change value, types of facilities that have changed, and any special circumstances or situations.

Appendix E: Determining Change Value Instruction Booklet

A systematic reporting process developed by the MAJCOMs can be used in determining installation imagery refreshment requirements. A proposed instruction and report format is provided in this appendix for use by the installations. The first step of developing the reporting process is performed by each MAJCOM. The second step is determining the change value and producing an installation report to be sent to the MAJCOM.

Step-by-step instructions for the installation for using the change model and developing a report are broken into following five steps:

- Determine Total Square Footage
- Collect Changes to the Installation
- Prepare Data for Model
- Input Data into Model
- Develop Installation Report

These suggestions are meant to provide guidance for the installation. These suggestions do not supercede MAJCOM requirements.

INSTALLATION INSTRUCTION SHEET

STEP 1 DETERMINE TOTAL SQUARE FOOTAGE OF ALL THE FEATURES OF THE INSTALLATION

- Obtain a current report of the installation's real property
- Real Property Flight can provide this information
- Convert all facilities using an area measurement to square footage using Excel
- Omit all facilities not using an area measurement
- Omit all land measurements
  - Unless land acquisition/release has occurring during the change period
- Ensure each facility's area is counted once
  - Real Property records record total square footage, then broken down by category code
- Sum all values to produce a total facility square footage for installation

STEP 2 COLLECT CHANGES TO THE INSTALLATION

- Sources for obtaining changes to the installation include:
  - ACES reports – Real Property and Project Management Modules
  - Demolition reports or records
  - Information about installation changes from the Engineering, Operations, Environmental, and Real Property Flights
- Use date of last imagery acquisition as starting point for change period
- Types of changes include:
  - New construction
  - Demolition
  - Additions to existing facilities
  - Changes to existing topographical features

STEP 3 PREPARE DATA FOR MODEL

- Determine the model category for each change
  - Identify the IRR category using the facility's category code
  - Place all changes without a category code into the Environmental category
  - All changes must be placed into one of the model's twelve categories and inputted into an Excel spreadsheet

- Use an Excel Spreadsheet to identifying and grouping the changed features by categories
    - The Excel spreadsheet should contain 13 categories. A brief description of each category is provided below.

INST_NAME_40	The name of the installation
FACT_ID_NR	A unique number assigned by the installation
CAT_NOMENCLATURE	A short description of the function of the facility
RP_AREA_AMT	Area value of the facility
AREA_UOM	The unit of measure for the facility's area
RP_OTH_AMT	Facility's value if another unit of measurement is used
OTH_UOM	Unit of measure for the facility if different measure is used
RP_CAT_PRES	Category Code assigned to the facility
TYPE	The type of change, i.e. demolition, new, addition
YR_COMP	Fiscal year the change was completed
IRR Category	Identifies which IRR Category for the facility
Coding	Number assigned to a category to sort the list by categories
Subtotal	Total square footage of each change within each category

<u>STEP 4</u> INPUT DATA FOR MODEL

- Input category weightings determined by MAJCOM into the equation
- Input the installation's changes for each category into equation
    - Each category is represented in the equation (located on the next page) by the letters A through L
    - The SF of the changes of each category are summed in the equation
- Input the total facility square footage of the installation into the equation
    - Multiply the change value by 100

$$\Delta V := \left(\frac{100}{T}\right) \cdot W_1 \left(A_1 + A_2 + \;..A_N\right) + W_2 \cdot \left(B_1 + B_2 + \;..B_N\right) + \;..W_{12} \cdot \left(L_1 + L_2 + \;..L_N\right)$$

where

ΔV	=	*Value representing the amount of change to the installation when compared with its imagery*
T	=	*Total square footage of the installation's features*
N	=	*Total number of features that have changed since the imagery was acquired*
Wi	=	*Category Weightings received from MAJCOM*
Ai	=	*Operations and Training features (total SF)*
Bi	=	*Mobility features (total SF)*
Ci	=	*Maintenance and Production features (total SF)*
Di	=	*Research, Development, Testing, &Evaluation features (total SF)*
Ei	=	*Supply features (total SF)*
Fi	=	*Medical features (total SF)*
Gi	=	*Administrative features (total SF)*
Hi	=	*Community Support features (total SF)*
Ii	=	*Housing features (total SF)*
Ji	=	*Dormitories features (total SF)*
Ki	=	*Utilities &Ground Improvements features (total SF)*
Li	=	*Environmental features (total SF)*

For example, changes in the Operations and Training category (Ai) would be summed and multiply by the category weight (W_1) received by the MAJCOM. A complete example is provided using data from Kadena Air Base.

Appendix F: Sample Report

An example is provided using data from Kadena Air Base. The category weights for each category were determined by the MAJCOM and are as follows:

Category	Weight
Operations & Training	37
Maintenance and Production	25
UGI	19
Medical	15
Mobility	12
Supply	10
Community Support	8
Admin	6
Dormitories	5
Housing	3
RDT & E	2
Environmental	1

Using the category subtotals from the list of changes from Kadena Air Base produces the following table (for example, the total SF of changes within the UGI category is 36,459):

Category	Subtotals
Operations & Training	68524
Maintenance and Production	66356
UGI	36459
Medical	248830
Mobility	0
Supply	67119
Community Support	278939
Admin	14921
Dormitories	461171
Housing	0
RDT & E	0
Environmental	0

Inputting this information into the equation and a total feature square footage of 29714309 results in:

$$\Delta V = \left(\frac{100}{29714309}\right)\cdot(37\cdot 68524 + 12\cdot 0 + 25\cdot 66356 + 2\cdot 0 + 10\cdot 67119 + 15\cdot 248830 + 6\cdot 14921 + 8\cdot 278939 + 3\cdot 0 + 5\cdot 461171 + 19\cdot 36459 + 1\cdot 0)$$

The equation calculates a change value of 46.8. The following is a sample report format to be used by the installation.

GEOBASE INSTALLATION CHANGE REPORT
KADENA AIR BASE
(RESEARCH EXAMPLE)

CHANGE VALUE **46.8**

DISCUSSION

Request funding for refreshment of base imagery. A change value of 46.8 justifies a refreshment of installation imagery an effective use of resources. Some important changes to the installation include:

- Approximately 500K of construction of dormitories
- Over 50K of VOQ construction
- A new Air Freight Terminal, providing mission critical operations
- A general change on the installation totaling over 1M square feet

ATTACHED

IMAGERY MAP

LIST OF CHANGES

IMAGERY MAP

KADENA AIR BASE CHANGED FEATURES

INSTL_NAME_40	FACT_ID_NR	CAT_NOMENCLATURE	RP_AREA_AMT	AREA_U0M	RP_OTH_AMT	OTH_U0M	RP_CAT_PRES	TYPE	YR_COMP	IRR Category	Coding	Subtotal
KADENA	1055	ACFT ARES SYS SPT	0		1	EA	116922	N/A	1998	Operations & Training	1	
KADENA	1064	ACFT ARES SYS SPT	0		1	EA	116922	N/A	1998	Operations & Training	1	
KADENA	1181	ACFT ARES SYS SPT	0		1	EA	116922	N/A	1998	Operations & Training	1	
KADENA	1280	DEFLECTOR,BLST			1	EA	116945	N/A	1999	Operations & Training	1	
KADENA	3400	TRML, AIR FRT	18,955	SF			141782	N/A	2000	Operations & Training	1	
KADENA	3401	TRML, AIR FRT	89	SF	0		141782	N/A	1998	Operations & Training	1	
KADENA	3507	SQ OPS	26,210	SF			141753	N/A	2000	Operations & Training	1	
KADENA	3628	COMM FCLTY	15,381	SF			131111	N/A	2000	Operations & Training	1	
KADENA	23628	COMM FCLTY	241	SF			131111	N/A	2000	Operations & Training	1	
KADENA	45019	TNG AID			1	EA	179371	N/A	2001	Operations & Training	1	
KADENA	45020	TECH TNG CLASSROOM	562	SF			171621	N/A	2001	Operations & Training	1	
KADENA	45105	TECH TNG CLASSROOM	2,700	SF			171621	N/A	2000	Operations & Training	1	
KADENA	45106	TECH TNG CLASSROOM	2,700	SF			171621	N/A	2002	Operations & Training	1	
KADENA	73335	ILS GLIDE SLOPE	86	SF	1	EA	134351	N/A	1998	Operations & Training	1	66,924
KADENA	851	BE STOR SHED	3,096	SF			219947	N/A	2000	Maintenance & Production	3	
KADENA	3422	SHP A/SE STOR FCLT	3,354	SF			218712	N/A	2001	Maintenance & Production	3	
KADENA	3466	SHP A/SE STOR FCLT	4,558	SF			218712	N/A	2002	Maintenance & Production	3	
KADENA	3470	VEH OPS PKNG SHED	4,836	SF			214428	N/A	2000	Maintenance & Production	3	
KADENA	3471	VEH OPS PKNG SHED	4,836	SF			214428	N/A	2000	Maintenance & Production	3	
KADENA	3551	ACFT COR CON	2,721	SF	0		211159	N/A	1998	Maintenance & Production	3	
KADENA	3639	SHP ACFT GEN PURP	2,244	SF			211152	N/A	2000	Maintenance & Production	3	
KADENA	45503	BE STOR SHED	7,440	SF			219947	N/A	2001	Maintenance & Production	3	
KADENA	45811	SHP CONVL MUN	18,116	SF			216642	N/A	1999	Maintenance & Production	3	
KADENA	47801	SHP, SRVLL INSP	15,155	SF			215582	N/A	1998	Maintenance & Production	3	66,356
KADENA	171	HSG SUP&STOR FCLTY	1,203	SF			442769	N/A	1998	Supply	5	2,883
KADENA	616	HSG SUP&STOR FCLTY	1,163	SF			442769	N/A	1998	Supply	5	
KADENA	760	HSG SUP&STOR FCLTY	386	SF			442769	N/A	1998	Supply	5	
KADENA	770	HSG SUP&STOR FCLTY	386	SF			442769	N/A	1998	Supply	5	
KADENA	1218	STOR, JET FL	0		80,000	BL	411135	N/A	1998	Supply	5	
KADENA	1219	STOR, JET FL	0		80,000	BL	411135	N/A	1998	Supply	5	
KADENA	3157	SHED SUP&EQUIP BSE	334	SF			442628	N/A	2000	Supply	5	
KADENA	3465	WHSE SUP&EQUIP BSE	438	SF			442758	N/A	2001	Supply	5	
KADENA	47099	ANCLY EXPLO FCLTY			1	EA	422275	N/A	1998	Supply	5	
KADENA	48953	STOR, IGLOO	1,991	SF	1	EA	422264	N/A	2001	Supply	5	
KADENA	48954	STOR, IGLOO	1,991	SF	1	EA	422264	N/A	2001	Supply	5	

KADENA	48955	STOR, IGLOO	1,991 SF	1 EA	422264	N/A	2001	Supply	5	
KADENA	48956	STOR, IGLOO	1,991 SF	1 EA	422264	N/A	2001	Supply	5	
KADENA	48957	STOR, IGLOO	1,991 SF	1 EA	422264	N/A	2001	Supply	5	
KADENA	49611	STOR MODULE BARCAD	52,380 SF		422271	N/A	1999	Supply	5	66,245
KADENA	626	COMPOSITE MED	231,766 SF	1 BD	510001	N/A	1999	Medical	6	231,766
KADENA	235	BSE ENGR ADMIN	1,375 SF	0	610127	N/A	1998	Administration	7	
KADENA	3151	TRAFFIC MGT FCLTY	10,791 SF		610142	N/A	2001	Administration	7	
KADENA	47899	MUN MAINT ADMIN	2,263 SF		610144	N/A	1998	Administration	7	14,429
KADENA	28	O/D RECTN PAVILION	1,132 SF	1 EA	750371	N/A	1999	Community Support	8	
KADENA	59	EDUCATION CEN	46,532 SF		730441	N/A	2002	Community Support	8	
KADENA	156	SAN LATRINE	544 SF		723392	N/A	1999	Community Support	8	
KADENA	178	DH, AMN(DET)	17,900 SF	1,000 PN	722351	N/A	2001	Community Support	8	
KADENA	334	CHILD CARE CEN	23,594 SF		740884	N/A	1998	Community Support	8	
KADENA	772	DH, AMN(DET)	15,521 SF	1,000 PN	722351	N/A	1999	Community Support	8	
KADENA	3629	RESTAURANT, BASE	8,400 SF		740735	N/A	2000	Community Support	8	
KADENA	4081	CHILD CARE CEN	23,594 SF		740884	N/A	1999	Community Support	8	
KADENA	9497	SCH DEPN DET SPT	32,927 SF		730783	N/A	2002	Community Support	8	
KADENA	20334	MWR SUP/NAF C-STOR	43 SF		740672	N/A	1998	Community Support	8	
KADENA	20335	MWR SUP/NAF C-STOR	43 SF		740672	N/A	1998	Community Support	8	
KADENA	24081	MWR SUP/NAF C-STOR	43 SF		740672	N/A	1999	Community Support	8	
KADENA	24082	MWR SUP/NAF C-STOR	43 SF		740672	N/A	1999	Community Support	8	
KADENA	46015	SP ENTRY CON BLDG	96 SF	0	730837	N/A	1999	Community Support	8	
KADENA	48090	MONUMENTS/MEMORL		3 EA	760512	N/A	1999	Community Support	8	
KADENA	70138	O/D RECTN PAVILION	560 SF	1 EA	750371	N/A	2001	Community Support	8	
KADENA	70613	O/D RECTN PAVILION	560 SF	1 EA	750371	N/A	2002	Community Support	8	
KADENA	71849	MISC O/RECTN FCLTY		1 EA	750581	N/A	1999	Community Support	8	
KADENA	74081	MISC O/RECTN FCLTY		2 EA	750581	N/A	1999	Community Support	8	171,532
KADENA	176	DORM AM PP/PCS-STD	66,736 SF	194 PN	721312	N/A	2001	Dormitories	10	
KADENA	177	DORM AM PP/PCS-STD	67,628 SF	194 PN	721312	N/A	2001	Dormitories	10	
KADENA	629	DORM AM PP/PCS-STD	66,661 SF	194 PN	721312	N/A	1999	Dormitories	10	
KADENA	630	DORM AM PP/PCS-STD	66,661 SF	194 PN	721312	N/A	1999	Dormitories	10	267,686
KADENA	180	WTR FR PMP STN	710 SF	1,821 GM	843316	N/A	1998	UGI	11	
KADENA	342	BLDG WTR SUP	299 SF		841169	N/A	1998	UGI	11	
KADENA	2834	SAN SEWAGE PMP STN	220 SF		832267	N/A	1999	UGI	11	
KADENA	3335	ELEC PWR STN BLDG	216 SF		811149	N/A	1998	UGI	11	
KADENA	3397	ELEC PWR STN BLDG	277 SF		811149	N/A	2000	UGI	11	
KADENA	3506	ELEC PWR STN BLDG	204 SF		811149	N/A	2000	UGI	11	
KADENA	4067	BLDG WTR SUP	299 SF		841169	N/A	1998	UGI	11	
KADENA	5011	SAN SEWAGE PMP STN	232 SF		832267	N/A	1999	UGI	11	
KADENA	9498	ELEC PWR STN BLDG	193 SF		811149	N/A	2002	UGI	11	
KADENA	46014	ELEC PWR STN BLDG	233 SF		811149	N/A	1999	UGI	11	
KADENA	49050	FR PROTEC WTR STOR	0	5 KG	843319	N/A	1998	UGI	11	2,883

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14. ABSTRACT

The United States Air Force is in the process of implementing GeoBase, an initiative to change how geospatial information resources are being acquired, implemented, exploited, and sustained on USAF installations around the world. Using GeoBase increases situational awareness and minimizes decision risk for all installation personnel. GeoBase is a geographic information system, using commercial-off-the-shelf software to provide one source for spatial information on an installation. GeoBase uses imagery as one layer of information. The accuracy of the imagery directly impacts the effectiveness of GeoBase.

The purpose of this thesis was to develop a decision model to be used in determining imagery refreshment in an installation's GeoBase program. A decision analysis model was developed based on the square footages of changes to the installation. A weighting method process was developed and used to better capture the mission priorities of the installation. This effort resulted in a mathematical equation providing a value representing the amount of change on an installation when compared with its imagery.

Results of this effort were tested using information from six installations from three different major commands. This model produces a value comparable across the Air Force and can assist in determining refreshment strategies at each MAJCOM.

15. SUBJECT TERMS

GeoBase, GIS, imagery, refreshment, management, mathematical model, weighting methods, weights, decision analysis

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